

AN ECOLOGICAL STUDY OF
MEDICINAL AND AROMATIC PLANT
VITEX NEGUNDO LINN

THE THESIS

SUBMITTED TO THE FACULTY OF SCIENCE
BUNDELKHAND UNIVERSITY, JHANSI

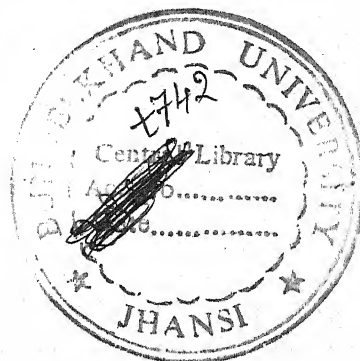
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY
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BY

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CONTENTS

TEXT

- i. Dedication
- ii. Supervisor Certificate
- iii. Acknowledgements

CHAPTERS :

Page No.

1. INTRODUCTION	1 - 6
2. STUDY AREA AND CLIMATE	7 - 16
3. PHENOLOGY	17 - 26
(a) Introduction	17 - 19
(b) Review of literature	19 - 21
(c) Materials and method	21 - 21
(d) Results and discussion	21 - 26
4. PHYSICAL CHARACTERSTICS OF SEED	27 - 42
(a) Introduction	27 - 29
(b) Review of literature	29 - 31
(c) Materials and method	31 - 35
(d) Results and discussion	36 - 42
5. SEED MYCOFLORA	43 - 47
(a) Introduction	43 - 43
(b) Review of literature	43 - 45
(c) Materials and method	45 - 46
(d) Results and discussion	46 - 47
6. SEED GERMINATION	48 - 99
(a) Introduction	48 - 50
(b) Review of literature	50 - 58
(c) Materials and method	58 - 64
(d) Results and discussion	64 - 99

7. GROWTH PERFORMANCE

90 - 205

(a) Introduction

90 - 92

(b) Review of literature

92 - 97

(c) Materials and method

98 - 107

(d) Results and discussion

108 - 205

8. BIBLIOGRAPHY

206 - 258

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Certificate From The Supervisor

This is hereby certified that the thesis entitled, "An ecological study of medicinal and aromatic plant - *Vitex negundo* Linn. " being submitted by Miss Renu Bhatt for the award of Ph.D. Degree in Botany contains original piece of research work.

It is further certified that-

- (a) The thesis embodies the work of the candidate herself.
- (b) The candidate has worked under my guidance and supervision for the period required under ordinance 7, and
- (c) The candidate has put in the required attendance in the department during U.P. period.

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RENU BHATT

INTRODUCTION

Man absolutely depend on plants for almost all the activities and requirements of life. It was the recognition of this utilitarian aspect of plants that seems to have initiated mans interest in them early in the anthropogenic history. The history of medicine in India can be traced to the remote past. The earliest mention of the medicinal use of plant is found in the "**Rigveda**" perhaps the oldest repository of human knowledge, having been written between 4500 to 1600 B.C. In "**Ayurveda**" the properties of various drugs have been suggested with logical details. The idea that plants could be used for treating diseases and healing wounds probably arose in the mind of the early man, Observations and inferences, accidents and intuitions, philosophy and traditions, meditation and sliding into deep and prolonged thoughts, all seems to have contributed in the birth and growth of Indian medicine.

During recent years chemists have synthesized potent remedies, such as arsenicals and antimalarial compounds, which have proved effective in the treatment of protozoal diseases. Sulphonamides, are useful in the treatment of bacterial diseases. Antibiotics have revolutionized the treatment of bacterial and ricketisial diseases and even some viral disease are said to be controlled by certain antibiotics. Diseases which were considered incurable few years

back are now curable by herbal the rapies. This necessitates to research on the ethnobotanical aspects of indigenous drugs.

MAN Versus Ecology

Ecology is the only science that needs minimum time and labour for its introduction to a layman Ecology indeed plays an important role in human welfare. Broadly vegetation, soil, air, water, micro and macro fauna form our environment, but of all these components, the vegetation plays a major role in stabilizing the structural configuration of nature. Potentially every plant occurring on this planet have one or the other medicinal property.

Medicinal plants are also living organisms. Their reproduction, growth and yield is affected by different factors. Various activities of man influence the growth and production of vegetation including MAP. These vegetations can be managed either for the physical and recreational benefits, they confer or for productive purposes.

Plants exercise a moderating influence on air, water temperature and other factors. Besides altering the physical and chemical properties of soil, they play important roles in checking flood, drought, erosion and other vagaries of nature.

It is well said **"Destroying vegetational wealth invites destruction of health"**. The plants play a protecting and promoting role in the health of man.

MAP Cultivation A new approach

The medicinal and aromatic plants that are used in Ayurvedic system of medicine are little known academically, but have sufficient commercial importance because of their catering to the Ayurvedic needs of our country. However, the large scale cultivation of these Medicinal and Aromatic plants (MAP) for profit depends on the active principle contents and not on their luxuriant growth.

Several factors such as soil, rainfall, altitude, method of cultivation, storage, marketing etc, play major roles for commercial success of large scale cultivation of these plants. The requirement of quality and ever increasing quantity of MAP raw materials keeps no other way than the systematic production of homogenous plant materials in controlled conditions. For this reason, the trend of quality improvement of MAP cultivation is getting newer dimensions all over the world.

It is particularly appropriate at the present moment, when the pharmaceutical companies of the world are emitting an unceasing flow of new synthetic drugs, that attention should be turned to the possible remedies that may be found among indigenous plants of this country.

Environment affect general growth conditions of the plant as well as formation of their active principles. Experimental data suggests that light plays a positive role in synthesis of active principles.

Selection of *Vitex* for present project

Trees and other plant communities including MAP are living creatures. Like other organisms, they germinate, grow, become mature, reproduce and ultimately die. Majority of life processes of plant are governed by various habitat factors such as climate, physiography, geology and biotic influences etc. Very little work has been done on MAP in relation to environmental conditions and productivity regime in our country (Singh et al, 1986; Nandi, 1992; etc) and particularly in Bundelkhand region. However, some inaugural ethnobotanical studies were conducted in this central part of India by Karnick (1981), Saxena and Tripathi (1989 and 1990) etc. Locally *Vitex negundo* is found growing naturally in Chandpura and Bangawa forest. Not only locally but Nirgundi is well distributed in tropical environments of India. Though it is widely distributed and is frequently used in various Ayurvedic preparations even then it has been neglected by the research workers. Hence in order to understand its various life processes particularly germination and growth dynamics in relation to various environmental factors the plant was selected for present study. The aim of this study is to understand its ecological requirements.

Ethnobotanical significance of Nirgundi.

V. negundo Linn. (Vern. Nirgundi) is a shrub or a small tree, grown for reclamation of forest land. It stabilize soil near railway tracts

which are often subjected to wind and water erosions creating traffic hazard. By planting as shelterbelts along the railway lines so that the uplifting of finer soil particles and deposition railway tracts is reduced (Gupta, 1979).

Branches of Nirgundi are used for manufacturing baskets. Leaves are considered tonic, also smoked for curing headache, catarrh, discutient. Leaves are useful in dispersing swellings of joints from acute rheumatism and of the testis from suppressed gonorrhea. Used in several Ayurvedic preparations. Also possesses insecticidal properties.

Juice of leaves is used for removing foetid discharge and worms from ulcers. An oil prepared with it is applied to sinuses and scrofulous sores. Decoction of leaves is used as a bath in the puerperal state of women.

The following quotation quoted from "Brahmavarchas" rightly speaks about the medicinal importance of *V.negundo* :-

“निर्गुण्डति शरीर रक्षति रोगेभ्यः तस्माद् निर्गुण्डी”

It means which protect our body from disease is called "Nirgundi". Dr. William Boric said "Nirgundi" is an "Indian Arnica". In Unani medical science Nirgundi is also known as "Vergay Sambhalu".

The bark of root is used as tincture in rheumatism or rheumatic arthritis. According to Dr. Nadkarni - "This medicine excite the nervous system, hence is very useful in headache specially in trigeminal neuralgia".

Proposed research design

For the present assignment, some suitable sites in the local forest area in and around Jhansi were selected after extensive yield surveys. The broad outline of the present research work conducted is as below :-

- * Periodical phenological observations.
- * Physical characteristics of seeds.
- * Mycoflora associated with the seeds.
- * Effect of various pre-sowing treatments on germination behavior of *V.negundo* seeds.
- * Nursery techniques in order to asses the effects of different external and internal factors on the pattern of growth performances during initial stages of establishment of *V.negundo*.

STUDY AREA AND CLIMATE

Jhansi district is the headquarters of Bundelkhand region of Uttar Pradesh .Geographically it is situated between 25°27` North of latitude and 78°35` East of longitude,with 271 meter above mean sea level in semiarid tract of plateau and hill region of central India.Jhansi is surrounded by M.P. on three of the four sides. The forest vegetation of Jhansi and its adjoining is transitional between Southern tropical dry deciduous type and the Northern tropical dry deciduous type.

STUDY SITE

For phenological study Chandpura forest (mixed dry deciduous) was selected after preliminary survey of the region.The forest is situated on Jhansi-Tikamgarh road near Orchha (M.P.).It is about 16 km. from Jhansi by road.The region is naturally bounded by river Betwa a tributary of river Yamuna.The forest is geographically situated more than 400m above msl on undulating plains between 28.4° - 26` and 25.8° - 40` N latitude and 78° - 26` and 79° - 26` E longitude.

NURSERY

8

Field experiments were conducted in the nursery situated near village Khoran, about 2km. southward on the Jhansi - Shivpuri national highway.

SOIL

Soil is the most important single factor controlling the distribution, production and quality of forest-tree. The salient feature of soil parameters are presented in table 2.1.

TOPOGRAPHY

The topography of the region lies within 300m above mean sea level in general and exceeds over 450m in some cases. The hypsometric curve of the region shows that about 67.7% of the area is under 300m and 28.7% lies between 300 and 400m with small area (3.6%) above 450m.

Betwa, Pahujje and Jamini are the main tributaries of the river Yamuna, flowing through the tract. The bank of these rivers are flanked by most of the forest of the region.

Table 2.1 Characteristics of soil types

Attributes	Soil Types							
	Garden	Black (B)	Red (R)	Sand (S)	B+S (1:1)	B+R (1:1)	R+S (1:1)	R+B+S (1:1:1)
1. pH	7.77	7.56	7.33	8.03	7.79	7.44	7.68	7.64
2. Organic Carbon (%)	0.42	1.39	0.44	0.18	0.79	0.92	0.31	0.67
3. Available N	156.8 Kg./ha	0.007 %	0.010 %	0.004 %	0.005 %	0.008 %	0.007 %	0.007 %
4. Available P Kg./ha.	28.56	11.44	8.06	7.82	9.63	9.75	7.94	9.10
5. Available K	313.6 Kg./ha	0.206 %	0.063 %	0.055 %	0.131 %	0.135 %	0.059 %	0.106 %

CLIMATE

The climate of these region is tropical dry subhumid and has a distinct seasonality. It is characterised by three season viz-summer, rainy and winter. The climatic records of Jhansi during the study period are summarized in the table (2.2) and depicted in fig (2.1).

RAINFALL

The rainfall of the area varies from 800-1000 mm with annual rainfall of 936 mm. The potential evaporation goes as high as 1400-1700 mm resulting in the moisture index value of 40-50. The rainfall is erratic because more than 90% of the rainfall is recieved within 10 weeks from July-mid september with many intermittent long dry spells. Total rainfall is recieved in less than 50 rainy days. Winter showers are meagre and uncertain. Drought is a rule rather than an exception. In the month of June and September drought is expected once in every three years and in July and August once in 7 years. Usually two consecutive years experience drought in 12 years. Monsoon generally commences by the last week of June but sometimes is delayed to the 1st week of July. It is usually withdrawn by mid of September.

In 1994 and 1995 total rainfall occurred was 551mm and 829.9mm in 32 and 51 rainy days respectively. While in first half of 1996 (January-June) total 138.2mm rainfall was recieved in 14 rainy days.

Table 2.2

Average monthly climatic conditions of Jhansi during the study period (1994 - 1996).
(From Pradeep Bihari, Courtesy of Indian Grassland and Fodder Research Institute, Jhansi.)

Months		Temperature °C		Relative Humidity		Rainfall	
		Maximum	Minimum	Period-I	Period-II	mm	Rainy day
January	A-	-	-	-	-	-	-
	B-	21.4	4.8	93	49	13.2	2
	C-	22.1	6.8	96	52	43.4	4
February	A-	-	-	-	-	-	-
	B-	27.3	7.9	94	55	0.0	0
	C-	26.5	9.1	95	47	10.8	2
March	A-	-	-	-	-	-	-
	B-	31.3	12.0	82	29	20.5	3
	C-	34.2	14.9	77	24	0.0	0
April	A-	-	-	-	-	-	-
	B-	38.3	15.6	58	23	2.6	1
	C-	39.0	19.4	50	14	2.8	1
May	A-	-	-	-	-	-	-
	B-	43.1	26.0	36	20	0.0	0
	C-	41.8	25.5	44	19	0.5	0
June	A-	-	-	-	-	-	-
	B-	41.7	27.2	62	36	60.6	5
	C-	39.1	27.7	59	35	80.7	7
July	A-	32.0	24.5	93	76	279.7	18
	B-	34.7	25.4	83	61	360.2	15
	C-	-	-	-	-	-	-
August	A-	31.4	24.2	94	76	119.2	10
	B-	31.3	23.4	96	77	211.0	17
	C-	-	-	-	-	-	-
September	A-	33.2	21.7	87	53	23.2	2
	B-	32.4	22.3	92	61	155.2	8
	C-	-	-	-	-	-	-
October	A-	33.6	14.8	86	27	0.6	0
	B-	33.9	16.3	88	31	0.0	0
	C-	-	-	-	-	-	-
November	A-	29.1	9.9	94	27	0.0	0
	B-	29.0	10.0	86	29	0.0	0
	C-	-	-	-	-	-	-
December	A-	25.8	6.0	94	29	0.0	0
	B-	24.4	7.2	94	40	6.6	0
	C-	-	-	-	-	-	-

Legends : A = 1994, B = 1995, C = 1996

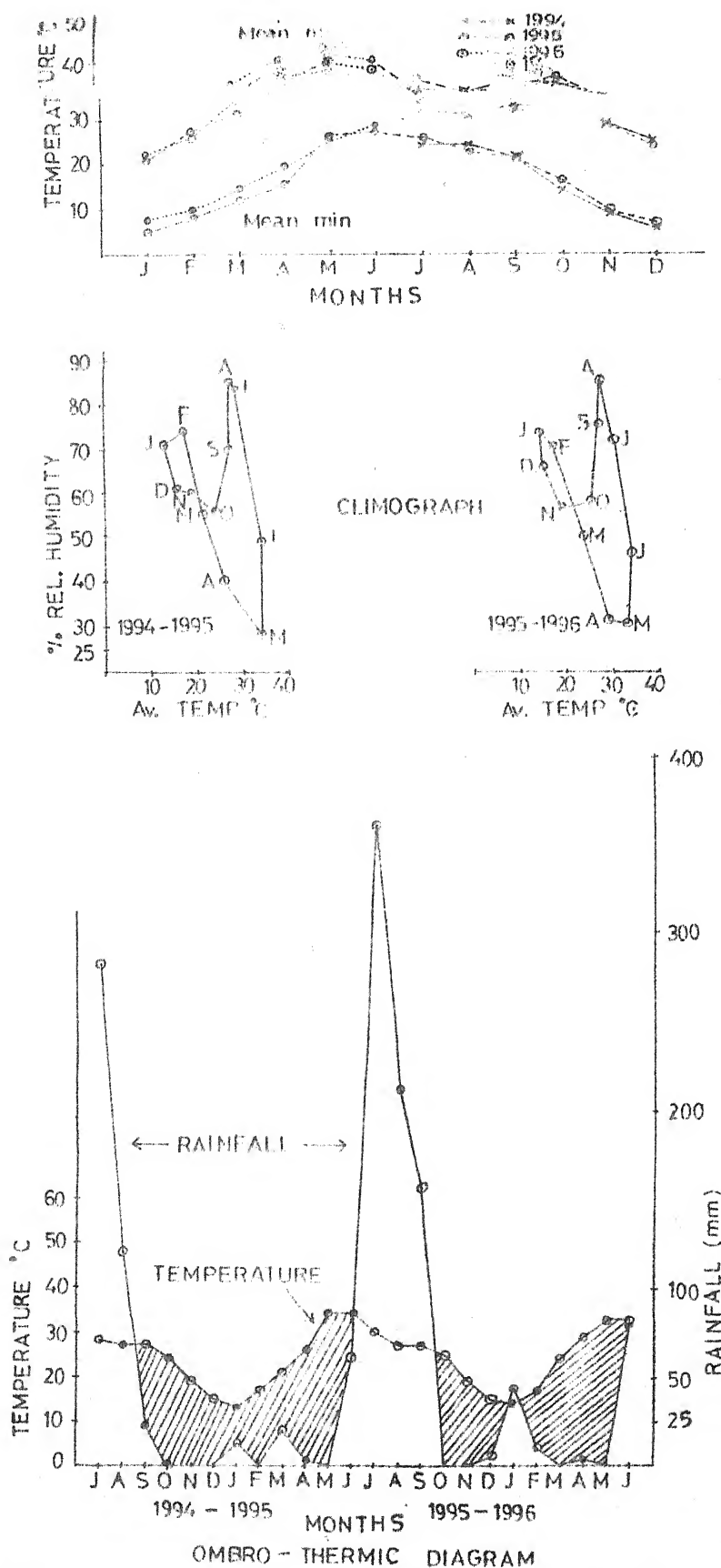


Figure 2.1 CLIMATIC CONDITIONS OF JHANSI

TEMPERATURE

The average annual temperature of the region is usually high and there is a vast variation between maximum and minimum temperature. In May and June temperature may sometimes touch a scale of 48°C . The minimum temperature reaches $4-5^{\circ}\text{C}$ in December and January. Such a high temperature coupled with windy days results in high potential evaporation. This often causes standing crops to wilt even though the soil moisture regime may not be very low.

During 1994 the highest temperature (43.5°C) was recorded in May and the lowest (23.2°C) in January. The year 1995 experienced highest (43.1°C) in May and lowest (21.4°C) in January. During 1st half of the year 1996 highest temperature of 41.8°C was noticed in May and the lowest of (22.1°C) was recorded in January.

OMBROTHERMIC DIAGRAM

The effectiveness of climatic factor like rainfall and temperature give a better understanding of wet and dry periods and can be well understood in a better way with the help of Ombrothermic diagram presented in fig 2.1 for the study period.

DISTRIBUTION

The species *Vitex negundo* Linn is distributed through the Subhimalayan tract ascending to 4000 feet from the Indus-East

wards and also Trans Indus. Often gregarious in small patches on the bank of streams and similar places. It is often planted in hedge by natives (**Parker, 1983**).

Survey of various published records and the personal communications indicate distribution of the species in East Africa, Indochina, Japan, Java, Madagascar, Phillipines, West Polynesia (**Raizada, 1977**) and Ceylon (**Benthall, 1984**) etc. covering different climatic regions.

In India it is common throughout Dehradun, Saharanpur division and Jounsar and is planted in hedge rows in village including hilly valleys (**Kanjilal, 1981**). The plant is common in most of the hotter parts of India. It is not abundant in neighbourhood of Calcutta, but may be found in thickest and shrubberies near villages and is occasionally cultivated in garden. A specimen was seen in 1943 on the west side of camac street (**Benthall, 1984**). It is distributed in Andhra Pradesh (**Chetty and Rao, 1989**), valley below Shimla (**Collet, 1980**), Chota nagpur, Bihar, North Bengal, Tirhut and Sunderban (**Prain, 1963**).

It grows profusely along waysides and borders of field at Rajpur. Sometimes planted in hedge rows (**Raizada, 1977**). It has also been found associated with the stony and gravelly surface and colonize rock crevices.

IDENTIFICATION OF CLONES

Negundo is an old generic name for certain maples with divided leaves. *V.negundo* Linn. is a member of the family verbinaceae. It is a large shrub or small sized tree.

Common names : Some of the common names of *V.negundo* are as follows :-

English :- Indian Privet.

Hindi :- Mewari, Nengar, Nirgandi, Sambhal, Sandbhalu, Shiwari, Sindhuka, Sinduari.

Bengali :- Nirgundi, Nishinda, Samalu, Sandbhalu (**Benthall, 1984**)

Uriya :- Begunia (**Prain, 1963**)

V.negundo is an aromatic shrub. The plant can be identified by following morphological characters:-

A shrub or small tree, branchlets^t, leaf stalks and inflorescence densely grey-pubescent, leaves digitately compound, leaflet-3, unequal, upper surface glabrous or nearly so, lower densely grey pubescent, flower blue purple crowded in short cymes forming erect, calyx bell shaped, 5 toothed, connate in a 2 lipped corolla, tube short limb 5 lobed, central lobe of lower lip usually largest. Stamen-

4, didynamous, carpel ovule-4, fruits are globose, resting on the somewhat enlarged calyx seeds and are ob-ovate.

UTILIZATION

V. negundo is very important from the medicinal point of view. The leaves and roots are used in Hindu medicine and are regarded as febrifuge and tonic. The twigs are used for basket making. Wood is used for building purposes and the branches for wattle work. Leaves are laid over stored grains to keep off insects. Leaves are also employed for a number of medicinal purposes, principally as a poultice for swollen joints and to cure headache. A decoction of leaves is given as a remedy for catarrh of the head and as an interval remedy for fever.

In Mysore a vapour bath is prepared from the plant to cure fever, cold and rheumatic infections. The plant is said to be a fair substitute for quinine. Leaf juice placed on aches to have relief from toothache. The leaves are smoked like tobacco to relieve headache and various other ailments. The plant is likely to be useful for afforestation works.

P H E N O L O G Y

INTRODUCTION

The term phenology is derived from the Greek word "**Phaino**" meaning "to show" or "to appear" (**Rathcke and Lacey, 1985**). Hence phenology is defined as "The study of seasonal timing of life cycle events."

The phenological pattern of any life cycle event can be quantitatively defined as a statistical distribution characterized by such parameters as time of occurrence (onset, mean, mode), duration (range), synchrony (variance) and skewness.

Phenology is an important function of forest ecosystem that relates the growth habit of a species with the physical environment. The periodic developments in plants at a place are largely determined by their changing environment. Phenology embraces all the studies of the relationships between environmental factors and periodic developmental phenomenon in plant. Each stage in periodic phenomenon is termed as phenophase and the sequence of different phenophases in a year is called phenodynamic analysis. It is a quantitative measurement of life cycle or specific phenophase. The main phenophases in plants are viz., seed

germination, bud bursting, leaf development, flowering time, fruit and seed dispersal, senescence and litter fall (**Leith**, 1970)

Phenology is generally describes as the art of observing the phase of life cycle of the activities of organisms as they occur through the year (**Leith**, 1973). The phenological events are meaningful in describing and explaining seasonal aspect of ecological phenomenon and help in felling series, utilisation of bioproduct and management of the species. There are many aspects of productivity, which can be categorised, predicted and evaluated on the basis of phenological attributes.

Phenology permits a calender to construct for the growth activity of plants especially the periods of initiation of new leaf bud, appearance of mature leaves, flower bud initiation, formation of mature flowers, young fruit formation and seed maturity etc. These informations are prerequisite for studies on the reproductive biology, breeding systems and silvicultural practices of a species (**Khosla; Reddy and Sehgal**, 1990)

Amenity plantation is an urgent need of modern era of rapid industrialization and urbanisation. It is needed to satiate the increased concern about environmental conservation. However, it is very difficult to plan amenity plantation without the knowledge of phenological calender of selected species. The need to evaluate phenological data on forest species has been felt long in the field of botany and forestry.

Inquiries into the phenology of tropical plants mostly take one or two approaches. The first is to examine the intrapopulational behaviour of single species or less commonly group to related species in relation to environmental factor (**Ashton, Givinish and Appanah**, 1988). The studies focus on proximate physiological releasing mechanisms.

The second approach is to document the phenology of plant guilds or communities in the interest of revealing broad, community - wide patterns of leafing, flowering or fruiting (**Koelmeyer**, 1959 a&b; **Frankie, Baker and Opler**, 1974; **Croat**, 1975 and **Sabatier**, 1985). These studies are often used to generate indices to the food supply available to animal consumers. They only rarely address physiological mechanisms, but can offer insights into the ultimate evolutionary causes that may have selected for particular pattern of phenology.

The phenological observations have been made in floristic, ecological and meteorological investigation. It is closely linked with the forestry regeneration programme. The phenological studies are useful in determining the character of forest floor sampling plants for the litter layer of forest (**Bhatnagar**, 1968).

Review Of Literature

The term 'phenology' was first used by **Shelford**(1929) to correlate the appearance of certain events. The stages in the life cycle of 37

weedy angiosperms have been studied in relation to various seasons and months of a year (**Ansari and Ghananand**, 1987)

Impact of grazing on phenology and life-form spectrum of vegetation has been studied (**Gupta & Singh**, 1990). Grazing has been found to effect phenology and floristic composition (**Misra**, 1970, **Sims et al**; 1976), and **Shankarnarayan**, 1977). However, **Dickinson and Dodd**, (1976) has reported that grazing has no effect on phenology of plants.

Some workers emphasize that the climatic conditions effect phenological events to a certain extent. **Blatter**, (1906) found correlation of flowering period with climate. **Ahlgren**, (1957) observed an obvious relationship between flowering and leafing responses of temperate forest of Minnesto. **Nanda**, (1962) has shown the importance of light in flowering of Teak. **Khan**, (1970) recorded the phenological observations of *Acacia nilotica* and found that the phenomenon is mainly governed by rainfall, temperature and evaporation. Rainfall primarily influences leafing, whereas, temperature effects flowering and fruiting. Flowering is effected both by relative humidity and evaporation.

Various other workers have also studied the phenological events of different plant species. some of them are viz; **Holmes**, 1942; **Sagreiya**, 1942; **Krishnaswamy and Mathauda**. 1954 ; **Ganapathya** and **Rangarajan**, 1964; **Kaul and Yutshi**, 1966; **Daubenmire**, 1972; **Medway**, 1972 **Kaul and Raina**. 1980; **Khosla, Shamet and Sehgal**.

1982; **Dar** and **Kachroo**, 1983; **Bisht**, **Verma** and **Toky**, 1986; **Navchoo** and **Kachroo**, 1986; **Beniwal**, 1987; and **Carel et al**; 1993.

Materials And Method

The study was conducted in Chandpura forest situated on the bank of river Betwa. The soil of the study site was sandy-red and of low quality. The site was visited fortnightly from May 1993 to May 1994. Different stages of phenophase and their sequences were recorded in every visit after keenly observing fifty random individuals of ***Vitex negundo***. Thus twelve month calender of phenological events was prepared. Phenograms fig (3.1) were drawn according to **Harper** (1906). Various phenophases studied were:

- (1) Budding,
- (2) Vegetative
- (3) Flowering
- (4) Fruiting,
- (5) seed maturation, and
- (6) Dispersed phase.

Results And Discussion

In the present study phenological calender of ***V. negundo*** range between May 93 to May 94. The sequence of different phenophases of ***V. negundo*** is depicted in fig (3.2). The phenological calender is exhibited in Table (3.1) Fig (3.3). The perusal of both the figures indicate that the fruiting and seed maturation phases of this

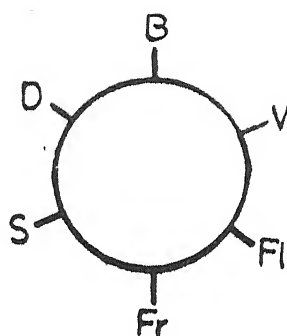


Figure 3.1 Phenograms as per Harper(1906)
SYMBOL PHENOLOGICAL PHASES:

B=Budding phase; V=Vegetative phase;
Fl=Flowering phase; Fr=Fruting phase;
S=Seed maturity phase; D=Dispersal phase.

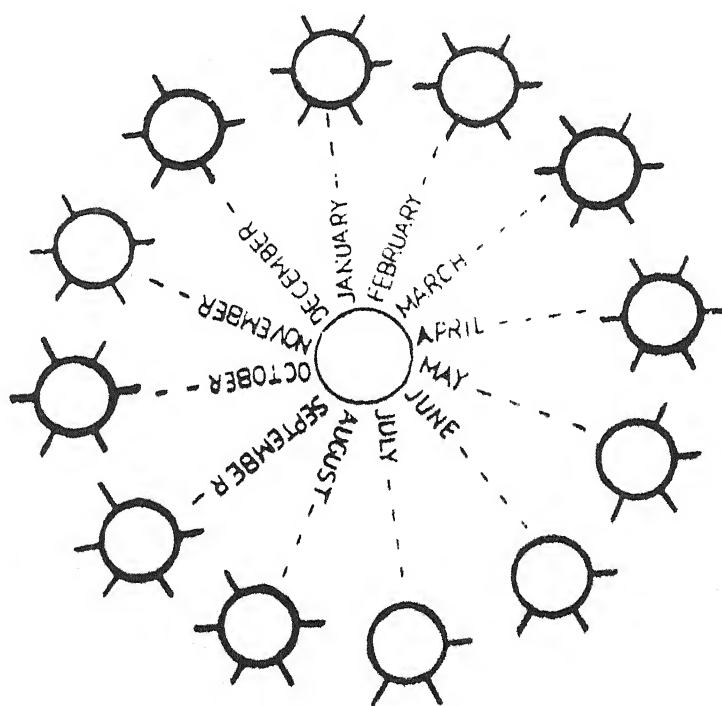


Figure 3.2 Phenodynamic analysis of *Vitex negundo* Linn.

Table 3.1 :- Phenological calender of *Vitex negundo* Linn.

Months	Phenophase					
	B	V	Fl	Fr	S	D
Jan	+	+	+	+	+	+
Feb	+	+	+	+	+	+
Mar	+	+	+	+	+	+
Apr	+	+	+	+	+	+
May	+	+	+	-	-	+
June	+	+	+	-	-	-
July	+	+	+	-	-	-
Aug	+	+	+	+	+	-
Sep	+	+	+	+	+	-
Oct	+	+	+	+	+	+
Nov	+	+	+	+	+	-
Dec	+	+	+	+	+	-

Legends : B = Budding phase
 Fl = Flowering phase
 S = Seed maturation phase
 + = Present

V = Vegetative phase
 Fr = Fruiting phase
 D = Dispersal phase
 - = Absent

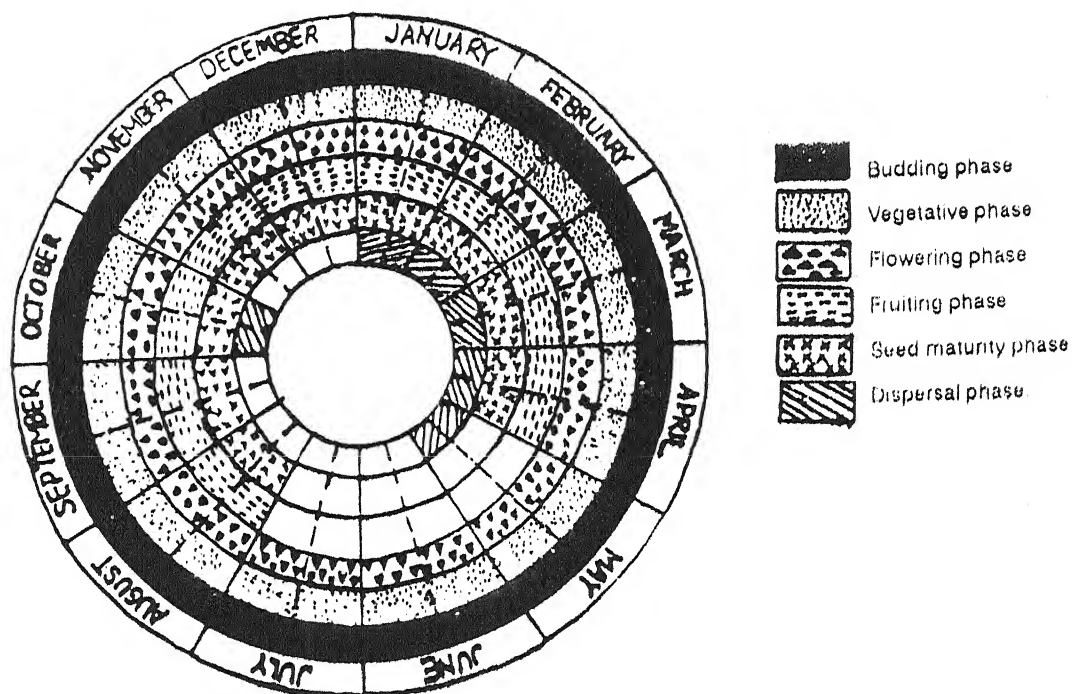


Figure 3.3 Phenological calendar of *Vitex negundo* Linn.

medicinal and aromatic shrub were totally absent during May, June and July. However, the phase of flowering occurred with varying intensities throughout the year (**Bhatt and Saxena**, 1995). The fruiting and seed maturation phases were observed between August to April. The peak of these phases were recorded in the month of November, whereas the lowest values were noted in the month of April. Both these phases were initiated during mid of rainy season and came to an end at the onset of summer months.

The phases of seed dispersion was recorded between January to May and in the month of October. Budding and vegetative phases were spread over the entire period of study.

The seed also start germination in the mid June and it continue till September as the germinating seed require optimum moisture and temperature (**Tothill**, 1977). The rainy season provided all the requirements. During winter and summer the germination was completely absent.

The flowering pattern was a synchronous i.e buds and flowers were at different stages of development even on the same tree. Accordingly the species had adapted for insect pollination rather than birds or other animals. The flowering pattern, showing a low rate in the month of February and March, gradually increases to peak and then decline in the same order, seems to support the level of out crossing by eliminating the effect of competition for the pollinator.

Phenological study revealed that diversity was very much affected by the climatic condition and moisture. Diversity was high in rainy season due to the growth of producer, more over maximum number of seed germinate during rainy season. In nature during rainy season the seeds subjected to alternate soaking and drying periods. This increase the seed coat permeability and thus induces germination.

Flowering in *V.negundo* normally happens throughout the year in varying intensities, but it happens to be highest in the month of November and lowest during February - March. It can be concluded that the flowering in *V.negundo* is related directly to the temperature.

It is seen that fruiting and seed formation does not place between May to July, which illustrate that high temperature and low relative humidity decreases fruiting and seed formation. The leaf fall increases with decrease in the atmospheric temperature. It is highest in the month of January.

Chapter - IV

PHYSICAL CHARACTERISTICS OF SEED

INTRODUCTION

Seeds are vehicles for the spread of new life. Seeds are raw material for the fashioning of myriad products. They are wealth, they are beauty, they are symbol to beginning. They are carrier of aid. They are message of friendship and goodwill. Seeds are source of wonder.

Seed is a highly complex biologically living substance. Both seeds and its germination are initial stages in the life history of a plant. A "seed" strictly speaking is "an embryo". It is a living organism embedded in the supporting or the food storage tissue.

Seed has been defined variously. Some of the definitions are as follows :-

* "Seed is the greatest miracle ever created by nature".

ANONYMOUS

* "The seed is a convenient unit in which to suspend growth, as it is so easily transported and dispersed".

LEOPOLD AND KRIEDEMANN (1975)

* "A true seed is defines as fertilised mature ovule that possesses an embryonic plant, stored material (sometimes absent) and a protective coat or coat."

KOZLOWSKI AND GUNN (1972)

* "Seed is a highly organised packet of energy that provides for the complete development of the primary plant body the emergent seedling".

McDONOUGH (1977)

Seed is the primary unit of dispersal and propagation. Its study becomes important from the viewpoint of deciding its quality. The inherent variability of seed is its reproductive strategies and its impact on coming population is determined by the study of seed characteristics. Such studies have been widely conducted and are reviewed by **Harper etal**; (1970).

The physical and morphological studies of seed include seed size, area, weight, water holding capacity, and composition of inert matter etc.

Seeds and fruits vary greatly in appearance, size, shape and in location and structure of embryo in relation to its storage tissue.

The physical characteristics of seeds can determine their germination behaviour in different environments.

REVIEW OF LITERATURE

Although pronounced seed polymorphism is exhibited in nature by several angiosperms but ecological studies on them have not received due attention.

Ponnammal et al; (1993) has reported that large sized seed of *Hardwickia binata* gave 100% germination while 60% germination was obtained in medium sized seeds. Root, shoot length and dry weight production were greatest in seedlings obtained from large seeds. The biomass production is comparatively also higher in large sized seeds. Similar observations between seed weight, seed germination, growth and biomass production of seedlings were also reported in other tree species viz; *Acacia tortilis* (**Pathak et al;** 1980); *Eucalyptus* (**Aguiare and Nakane,** 1983); *Casuarina equisetifolia* (**Halos,** 1983); *Leucaena leucocephala* (**Gutpa et al;** 1983; **Natarajan and Rai,** 1984); *Pines* (**Thapliyal,** 1986); and in *Pruce* (**Singh et al;** 1990).

In Cow pea seed vigour was high in large seeds followed by medium sized seeds (**Sinha et al;** 1988). Effect of seed size on germination was studied by various workers : **Maranville and Clegg,** 1977 : **Wood et al;** 1977; **Dighe and Patil,** 1981; **Mathur et al;** 1982; **Bhatt et al;** 1988; **Srimathi, et al;** 1991; **Verma and Singh** 1992.

Seed polymorphism has been observed in many plants particularly in leguminous herbs and tree species (**Pathak et al**; 1974 & 1980; **Shukla and Ramakrishna**, 1981; **Roy and Pathak**, 1983, **Nagaveni and Anantha**, 1986).

When seed is dormant or very slow in germination, a rapid test is extremely useful. To gain reliable information about the viability of seed in a shortest possible time may be very helpful.

Baldwin, (1942) classified direct test of viability into three categories - physical, biochemical and physiological. Among the physical test the most inexpensive is the simple cutting test. **Toumey and Korstain**, (1947) classified cutting test as one of the method of testing viability of seed. **Versepay** (1955) found cutting test is the best for distinguishing the normal viable seeds.

Biochemical staining tests have shown that the viable seeds are visibly stained, whereas, the non-viable seeds are not. The first chemical used for staining procedure was selenium. Later on 2,3,5 - Triphenyl tetrazolium chloride (TZ salt or 2,3,5 - T) was used as indicator for determining the viability.

Topographical determination of the viability of seed by TZ salt was first introduced by **Lakon**(1942). **Lakon** (1942) established that all living cells of seed, which respire, reduce a colourless solution of 2,3,5 - Triphenyl tetrazolium chloride or bromide into a red colour compound called formazone.

In India TZ staining has been used to test the viability of Paddy seeds by **Venkataraman** (1951). **Moore** (1973) described the use of TZ staining for assessing seed quality and the basis of topographical patterns, Seeds of Maize and Wheat (**Agrawal et al**; 1973) showed positive correlation as between germination percentage and viability percentage determined by TZ test.

In FRI Dehradun seed of many forest trees were tested for their viability with TZ staining by **Gupta and Raturi** (1975).

MATERIALS AND METHOD

Seeds used for raising seedling should be of known purity, appropriate class and invariably obtained from potentially healthy stocks. With these objectives in mind, various physical characteristics of ***Vitex negundo*** were determined. For the physical characters following studies were performed on ***V.negundo*** seeds :-

- (I) Pure seed and its component,
- (II) Seed size,
- (III) Seed weight,
- (IV) Number of seed,
- (V) Moisture content,
- (VI) Water holding capacity, and
- (VII) Viability

(I) Seed and its component

From the composite sample of seeds, collected from Chandpura forest pure seeds were physically separated after the removal of its non-seed components. Five replicates of 100 g seeds each were used. Following components were severed from the replicates :-

- (a) Pure seed,
- (b) Calyx of the seed, and
- (c) Pedicel of the seed.

After separation, samples were weighed and percentage composition was calculated.

(II) Seed size

For seed size study 100 seeds were used. Each of them was measured individually for determining its length and breadth with the help of a Vernier Calipers.

(III) Seed weight

For determining seed weight 100 seeds were weighed individually on a chemical balance using standard rider.

(IV) Number of seeds

5 replicates of 1g each were used. The number of seed present in each of the replicate was counted individually.

Freshly collected seeds (5 replicates of 1 g each) were weighed and immediately oven dried at 80°C for 48 hours for recording their dry weights. The decrease in weight was determined and the moisture content was calculated as follows :-

$$\text{Percentage Moisture} = \frac{W - W_1}{W} * 100$$

Where W = Fresh Weight

W_1 = Oven dry weight

(VI) Water holding capacity

5 replicates of 1g each were initially weighed after collection. The replicates were soaked in equal volume of distilled water at room temperature ($16 \pm 2^\circ\text{C}$) for 48 hours. Imbibed seeds were weighed after blotting their surface dry. They were now placed in an oven at 80°C for 48 hours for determining their dry weight.

Percentage of imbibed ater, relative turgidity, and saturation deficit were calculated for each of the samples as follows :-

$$\text{Percentage of imbibed water} = \frac{\text{Saturated weight} - \text{Fresh weight}}{\text{Fresh weight}}$$

$$= \frac{W_2 - W_1}{W_1} * 100$$

$$\text{Relative turgidity} = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Saturated weight} - \text{Dry weight}} * 100$$

$$= \frac{W_1 - W_3}{W_2 - W_3} * 100$$

$$\text{Saturation deficit} = \frac{\text{saturated weight} - \text{fresh weight}}{\text{saturated weight} - \text{dry weight}} * 100$$

$$= \frac{W_1 - W_3}{W_2 - W_3} * 100$$

Where W_1 = Fresh weight

W_2 = Saturated weight and

W_3 = Oven dry weight

(VII) Viability

Seeds of three consecutive years, viz. 1994, 1995 and 1996 were soaked separately in equal volume (250 ml each) of distilled water for 24 hours. Soaked seeds were divided into two groups of 400 seed each. For rapid estimation of viability the seeds of first group were subjected to cutting test, whereas the seeds of the second group were tested by biochemical staining.

During cutting test, the soaked seeds were simply cut opened with the help of a nut-cutter. The number of empty (without embryo) or filled (with embryo) seeds were recorded.

For biochemical staining the seeds were cut into two equal parts passing through the centre of the embryo. The cut seeds were immersed in petridishes containing freshly prepared 0.1% solution of 2,3,5 Triphenyl tetrazolium chloride (TTC). The petridishes were placed in dark for twelve hours. The seeds were then observed for red colouration. The coloured portions of seed were infact the stained embryos. Viable seeds are only able to show this colouration. The number of coloured and non-coloured seeds were recorded. Percent viability of seeds were calculated by following formula :-

$$\text{Percent Viability} = \frac{\text{Total number of viable seed}}{\text{Total number of seeds examined}} * 100$$

RESULTS AND DISCUSSION

Physical characteristics of *V. negundo* seeds are provided in tabulated form. The results and discussion of various parameters related with the physical characteristics of seeds are as follows:-

(I) Seed and its component

Table 4.1 contain data on composition of various seed components as percentage by their weight. Composition of pure seed was 92.78%;whereas calyx and pedicel shared 4.92 and 2.3% compositions respectively. This suggest that nearly 7% of the seed lot consist of inert matter and the rest of pure seed component. The presence of only dry persistent calyx and pedicel on form of inert matter in seed component proves th e fact that seeds of other species etc. does not contaminated of *V. negundo* seeds.

(II) Seed size

Table 4.2 display the physical dimension, i.e. length and breadth of *V.negundo* seeds, Average length and breadth of seeds are alike. These data confirms the spherical appearance of *V.negundo* seeds. Smallest seed was of 2.10-2.30mm diameter and the largest of 3.60-3.70mm diameter.

Table 4.1 Seed , non seed component of *Vitex negundo* L seeds*

Calculation heads	Components (g)		
	Calyx	Pedicel	Seed
AV	4.92	2.30	92.78
SE \pm	0.13	0.28	00.26
Max	5.30	3.30	93.40
Min	4.55	1.58	92.00

*5 Replicates of 100 g each

Legends : AV = Average SE = Standard error
 Max = Maximum Min = Minimum

Table 4.2 Weight (mg) and size (mm) of *Vitex negundo* L.seeds*

Calculation heads	Weight	Length	Breadth
AV	12.90	3.01	3.01
SE \pm	00.40	0.03	0.03
Max	23.00	3.70	3.60
Min	03.00	2.30	2.10

* Average of 100 seeds

Legends : AV = Average SE = Standard error
 Max = Maximum Min = Minimum

(III) Seed weight

Seeds of *V.negundo* are light in weight because an average weight of seed is 12.9mg. The weight of seed exhibit great variation. Some of the seeds were as light as 3.00mg. whereas, few of the seeds were as heavy as 23mg.

(IV) Number of seeds

As regards number of seeds present in per gram samples, the table 4.3 informs that it ranges from 74 to 83 with an average of 77.6. Those values nearly corresponds with the calculations of Table 4.2.

(V) Moisture content

Table 4.4 expresses the amount of moisture present in *V.negundo* seeds. The moisture percentage ranged between max 1.40% and min 0.98% with an average moisture of 1.19%

(VI) Water holding Capacity

Table 4.5 suggests the Percent of imbibition, relative turgidity and saturation deficit of *V.negundo* seeds. The highest percentage of imbibition was 44.0% and lowest 36.0%.

The relative turgidity, vibrated between max 3.74 to min 2.18%. As such the saturation deficit, which was 97.82% and 96.26% higher

Table 4.3 Number of seed* per gram of samples of *Vitex negundo* L.

Calculation heads	Number of seed per gram
AV	77.60
SE \pm	01.57
Max	83.00
Min	74.00

* 5 Replicates of 1g each

Legends: AV = Average

Max = Maximum

SE = Standard error

Min = Minimum

Table 4.4 Percentage of moisture present in *Vitex negundo* L. Seeds*

Calculation heads	Moisture percentage
AV	1.19
SE \pm	0.09
Max	1.40
Min	0.90

* 5 Replicates of 1 g each

Legend : AV = Average

Max = Maximum

SE = Standard error

Min = Minimum

Table 4.5 Percentage of imbibed water, Relative turgidity, saturation deficit of *Vitex negundo* L. seeds*.

PARAMETERS			
Calculation heads	Percentage of imbibed water	Relative turgidity	Saturation deficit
AV	39.60	2.95	97.05
SE \pm	01.43	0.30	00.30
Max	44.60	3.74	97.82
Min	36.00	2.18	96.26

*5 Replicates of 1 g each

Legends : AV = Average

Max = Maximum

SE = Standard error

Min = Minimum

Table (4.6a) Percent viability of *Vitex negundo* L. seeds* by cutting as affected by storage period.

Character	1994 (Two year old)	1995 (One year old)	1996 (Fresh)	SEm \pm	C.D. _{0.05}
Viable seed	90.00 *(71.75)	93.00 *(74.73)	95.75 *(78.24)	1.60	3.93
Non viable seed	10.00 *(18.25)	7.00 *(15.26)	4.25 *(11.76)	1.60	3.93

*4 Replicates of 100 seeds each.

Angular values in parenthesis

SEm = Standard error mean

C.D. = Critical difference

Table (4.6b) Percent viability of *Vitex negundo* L. seeds* by biochemical test affected by storage period.

Character	1994 (Two year old)	1995 (One year old)	1996 (Fresh)	SEm \pm	C.D. _{0.05}
Viable seed	22.00 *(27.91)	23.50 *(28.96)	36.75 *(37.30)	1.30	3.17
Non viable seed	78.00 *(62.08)	76.50 *(61.03)	63.25 *(52.69)	1.30	3.18

*4 Replicates of 100 seeds each.

Angular values in parenthesis

SEm = Standard error mean C.D. = Critical difference

and lower respectively. The average values of relative turgidity and saturation deficit were 2.95 and 97.05 respectively.

(VII) Viability

Table 4.6(a&b) specifies the estimation of percent viability by both cutting and the biochemical staining of *V.negundo* seeds respectively. The results show that highest viability was obtained in freshly collected seeds. Viability decreased with the increase in storage time of seeds.

In cutting test maximum 95.75% viability was recorded in freshly collected seeds (1996 sample) followed by one year old(1995) seeds. The minimum 90% viability was noticed in two year old seeds(1994 samples).

Similarly in biochemical staining maximum 36.75% viability was observed in freshly collected seeds and minimum (22%) in seeds collected in 1994.

In cutting and biochemically staining test maximum 10% and 78% and min 4.25% and 63.25% non-viability was recorded in seeds collected in 1994 and 1996 respectively.

Chapter - v

S E E D M Y C O F L O R A**INTRODUCTION**

Seeds are vitally significant for healthy production of any crop. They are supposed to carry pathogens. Microorganisms associated with seeds cause extensive damage to them. In some cases, even the nutritive value of seed get deteriorated (**Mishra and Kanaujia, 1973; Bilgrami et, al., 1976; Sinha and Prasad, 1977**). While in others, the changes brought about in seeds by microorganisms affect the process of seed germination (**Grewal and Pal, 1965**).

The occurrence of fungi in or on seed surface depend on their ability to survive and to proliferate under extreme dry conditions. It seems that the presence of moisture is a prime factor in colonization of seed by fungi.

A major objective of seed health testing is assesment of the planting value of seeds. Such tests reveal not only germination percentage of seed lots but the presence of disease as well.

REVIEW OF LITERATURE

As per surveys of the literature ,the first available recorded evidence of realising the importance of seed borne fungi is that of

Remnant (1937). Presently several informations about seed mycoflora are available viz., **Mathur and Flavia** (1975); **Madhav Rao** (1977); **Flannigan** (1978) ; **Bateman** (1979) ; **Narayan and Prasad** (1981) ; **Nair** (1982) ; **Reddy and Dayanand** (1983) ; **Dadwal et,al.** (1986) & **Yadav and Duhan** (1992).

Many fungi are serious parasites of seed primordia and maturing seeds and they reduce yield of seeds both qualitatively and quantitatively (**Neergaard**,1977).

As regards ***Vitex negundo*** a considerable work has been done in India most of them report occurrence of different fungi on various part of this plant.

In 1914, **Sydow** reported a fungus ***Ramularia viticis*** from Tamilnadu causing leaf spot on ***V. negundo***. **Mitter and Tondon**, (1935) observed ***Poria*** spp on leaves of this plant from Allahabad. **Stevens and Pierce**, (1933); **Uppal et,al.**, (1935); and **Stevens and Rayan**, (1939) have noticed leaf spot disease of ***V. negundo*** due to the presence of ***Asterina sphaerotheca***. ***Cercopora viticis*** also caused leaf spot disease in Karnataka, Hyderabad and Darbhanga (**Govindu** and **Thirumalachar**, 1956; **Rao**, 1962; **Yadav**,1963; & **Pandotra and Ganguly**, 1964). **Agarwal and Hasija** ,(1961) racognized ***Cercospora agarwali*** on 'nirgundi' leaves from Jabalpur. ***Pithomyces maydicus*** and ***Curvularia lunata*** were observed on leaves in Bedagara (Kerala) and Bhagalpur (**Ponnappa**, 1967; and **Roy**, 1976).

On dead stem of *V.negundo* , the fungi *Ophioceras petrakii* (Tilak and Kale, 1969), and *Massaria kamatti* (Bordoloi et,al., 1971) were recorded in Aurangabad .*Crumenula indica* and *Boerlagella indica* (Tilak and Kale, 1970), and *Mytilidon kamatti* (Tilak and Jadhav, 1970), were observed in Awarad whereas, *Tremetasphaeria indica* (Tilak and Jadhav, 1971) was noticed in Hallali Decan.

Diatrype viticis was interesting fungi isolated from Khandala in association with the bark of *V.negundo* as saprophyte (Tendulkar,1970).

Bagnisiella vitatis was also recorded on *V.negundo* from Khandala by Vaidya (1980).

However it seems that no work has been carried out so far to study the fungi associated with the seed of *V.negundo*. Thus, an attempt was made to determine mycoflora of 'Nirgundi' seeds.

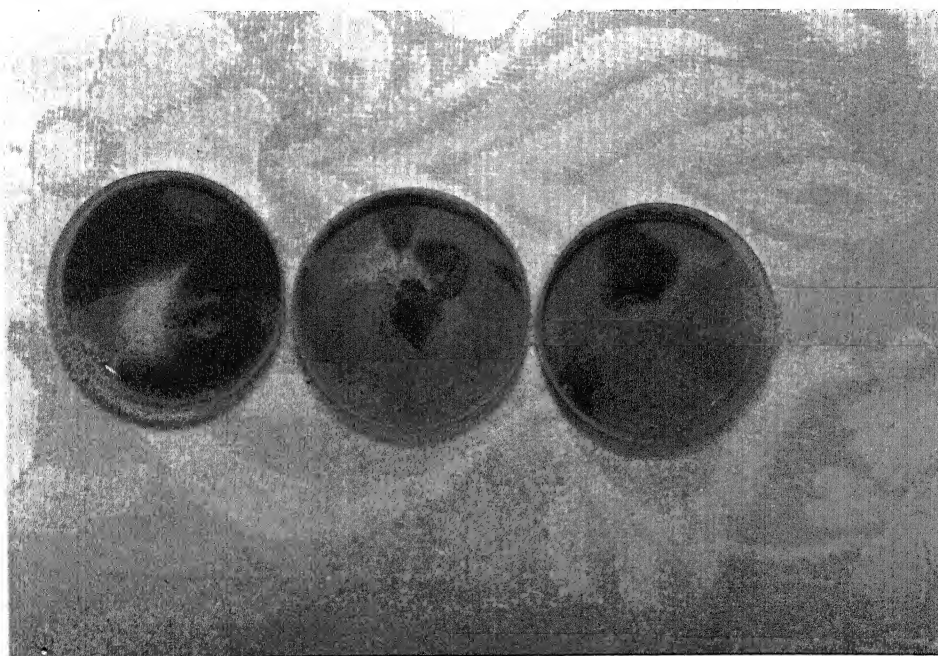
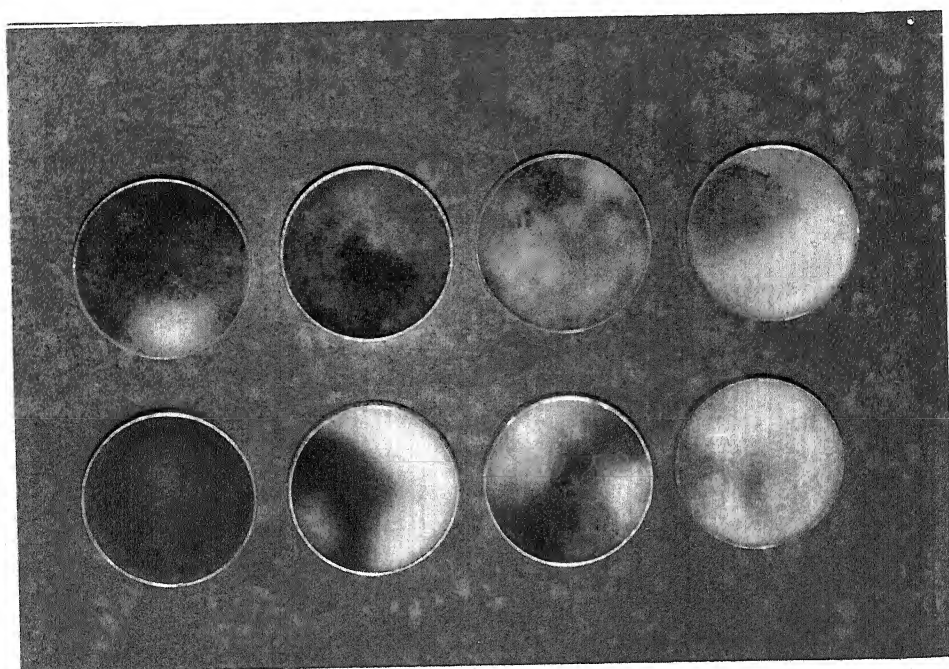
MATERIALS AND METHOD

The most common method used in the study of mycoflora of seeds is the standard incubation method i.e the agar plate method (Neergaard, 1977).

In the agar method seeds were directly plated on Potato-Dextrose-Agar (PDA). In other methods seeds were washed in distilled water

PLATE - 1 : PDA culture of seed mycoflora in pre soaked leachates of *Vitex negundo* Linn.

PLATE - 2 : PDA culture of seed mycoflora in dry seeds of *Vitex negundo* Linn.



for 5 minutes, then two or three drops of this wash-water were placed on agar medium.

To isolate the external seed mycoflora these plates were incubated at 27-28° C for 7 days under diffused light. Plates were examined every other day starting from 3rd day of incubation.

RESULTS AND DISCUSSION

Total eight fungi were isolated from the seeds of *V. negundo*. One of the belonged to class Ascomycetes, four to Deuteromycetes and three to Zygomycetes.

Seed washing test revealed fungal spore of five different genera. The most important and dominating fungi was *Mucor abundance* and *Rhizopus stolonifer*. Other fungi encountered were *Alternaria solani* *Eurotium spp*; *Helminthosporium spp*; and *Pacilomyces spp*.

When dry seeds were directly placed on PDA, four fungi of four different genera were recorded. Amongst them *Aspergillus niger*, *Mucor abundance* and *Rhizopus stolonifer* were dominant. Interestingly fungi known to be serious pathogen of some crop namely *Choanophora cucurbitarum* was also recorded in the present study.

Fungi associated with *Vitex* seeds affected its germination process. However *A.niger*, *M.abundance* and *R.stolonifer* were lost during seed germination.

In a short process of seed imbibition, the fungus may derange the cell organelles. Russel et, al. (1982) demonstrated ultrastructure change in the fungus infected maize (*Zea Mays*) seed imbibed for 12 hours only.

Results of several workers indicate that externally seed borne fungi may lower the protien content of seed (Singh et, al. 1973; 1974; Jamaluddin et, al. 1977; & Sinha and Prasad, 1978). The phytotoxic effect of fungi present on seed surface may lower or inhibit the seed germination.

Trimodal seed transmission of plant pathogens is a testimony substantiated by cumulative literature (Baker, 1972; Neergaard, 1977; Sinha, 1977; Khare and Sinha, 1983). Such pathogens are associated with seeds either externally, internally or are accompanied with them. Imbibed seeds are an excellent substrate for the proliferation of microbes either inside or on its surface.

S E E D G E R M I N A T I O N**INTRODUCTION**

Germination is an important event in life history of plant (**Pelton**, 1953; **Misra** and **Ramakrishna**, 1959; **Lodge**, 1959, 1962 a and b; **Ratcliff**, 1960 and 1961; **Kew**, 1961; **Cook**, 1962; **Bodwen**, 1964; etc.). The process of germination is not easy to define. All definitions seems to explain it as forcing of the radical through seed coat. It has been defined variously as follows -

AGRAWAL(1987) -"The emergence and development of seedling to a stage where its essential structures indicate Whether or not it is able to develop further to produce a normal plant under favorable conditions in soil".

EVENARI(1957) - describe germination as "three overlapping processes (a) imbibition causes the seed coat to swell and eventually break, (b) increased respiration, assimilation and enzymatic activities indicate the use of stored food and translocation to growing regions, and (c) enlargement results in the emergence of radicle and plumule".

ISTA(1976) -"The emergence and development of the seedling to a stage where the aspect of its essential structures indicates whether

or not it is able to develop further into a satisfactory plant under favourable conditions in soil".

JUSTICE(1977) -"Germination is the embryo emergence and the development of those essential structures that enable a normal plant to develop under favourable conditions".

MAYER AND MAYBER(1963) -"That group of processes which cause sudden transformation of dry seed into the young seedling".

McDONOUGH(1977) - "Germination is reactivation of growth triggered by environmental stimuli as simple as availability of water and oxygen as complex as temperature, light, endogenous inhibitor and promoter interactions".

Seeds germinate only in appropriate environmental conditions. The process starts with the imbibition of water through seed coat. Once imbibition is completed, seeds begin to germinate and seedlings emerge out.

Arousing a dry seed to start growth into a new plant involve four group of processes i.e.

- (1) Imbibition of water
- (2) Formation of enzyme system
- (3) Commencement of growth and radicle emergence and

(4) The growth of the seedling with the characteristic feature associated with the subterranean plant upto the time of emergence from the soil (**Leopold and Kriedemann**, 1975)

Germination is an enzyme requiring process and is, therefore, dependent on the respiratory activities of the seed. The process of germination leads eventually to the development of the embryo into a seedling.

REVIEW OF LITERATURE

Seeds or plant propagules need proper temperature, moisture and air supply for initiating germination or sprouting. The spread of germination over a period of time was observed in many species by **Koller**, (1972). A general theoretical model for germination strategy of seeds under varying conditions of survival has been proposed by **Cohen**(1966, 1968).

For germination, availability of water at a given period of time is determining factor. Germination is not possible without uptake of water and exchange of gas. Enzymatic changes necessary for germination do not take place in the absence of water and thus dormancy is retained (**Ambasth**, 1988).

Imbibition is a physical process which is related to the properties of colloids. In seeds the chief component which imbibe water is protein(**Mayer and Mayber**, 1982). Water status not only depend on nature and composition of seed coat but also on imbibition time

which alter various metabolic activities - chiefly the synthesis of enzyme for gene replication and growth provided other factors are not limiting (**Osborne**, 1977).

In pretreatment studies on the germination of ***Acacia senegal*** seeds recommend that untreated seeds should be used for field sowing and 12-24 hours presoaking in water for nurseries (**Danthus, etal**; 1992). The water imbibition in the seeds of ***Acacia senegal***, ***Prosopis cineraria*** and ***Mimosa hamata*** was effective in germination enhancement (**Mehta and Sen**, 1994).

Although seed size and shape show a remarkable constancy and are genetically determined, the phenomenon of somatic polymorphism is well known (**Harper etal**; 1970). Medium sized seeds of ***Acacia mellifera*** recorded the highest germination. Small seeds were characterized by low germinability (**Srimathi etal**; 1991).

Gupta etal;(1983) reported that the seed size of ***Leucaena leucocephala*** affected both germination and initial plant growth. **Goor and Barney**, (1976) also noted that the seed size influence germination in ***Eucalyptus citriodora***. Large sized seeds of ***Prosopis glandulosa*** gave better germination (**Faruqii and Ihsan**, 1991).

Effect of light on germination is called Photoblastism (**Evenari**, 1956). The importance of light as a factor in germination of seeds has long been recognized.

The stimulation of germination by light is ordinarily quantitative. **Isikawa** and **Fujii**, (1961) reported the quantitative effect of light on **Rumex** seeds. **Flint** and **Mc Alister**, (1937) found that red light is most effective in breaking dormancy. They found that both blue light and especially far red light are very inhibitory of germination.

In **Nigella** long irradiation of blue light (**Isikawa**, 1957; **Wareing** and **Black**, 1957; 1958; 1958; and **Evenari et al**; 1957) showed that it can in fact inhibit germination. Seeds of **Chorchorus olitorius** gave significantly higher germination in light than in dark ($P \leq 5\%$). Germination was also fast in light rather than in dark showing that it may be stimulated by light (**Okusainya**, 1979).

The regulation of germination of seeds by light would be advantageous in adapting them to their habitat (**Mayer** and **Mayber**, 1982). The maximum germination in seeds of **Acacia catechu** is caused by low wavelength of visible spectrum (blue light), in **Butea monosperma** by blue and red light and in **Bauchanania lazan** by the absence of light (**Agrawal** and **Prakash**, 1978). Light inhibition of seed germination was shown in **Nerium oleander** (**Datta**, 1961), **Phacelia tenacetifolia** (**Chen** and **Thimann**, 1965). In **Eclipta alba** 82% germination in continuous light, 62% germination in diffused light and very poor germination in darkness was observed **Ramakrishnan**, (1960). Maximum germination of **Tridax procumbens** occurred in light whereas they failed to germinate in total dark (**Mall** and **Raina**, 1961).

Dogfennel seeds were found to be strongly photoblastic with no germination in dark. **Yankeweed** seeds are moderately photoblastic. Germination for both species increased in response to red light (650nm) indicating phytochrome regulation (**Macdonald et al;** 1992).

The process of rupturing or weakening the seed coat by mechanical or other means is called scarification. Seed dormancy may be broken by several methods of scarification. Recently effect of different methods of scarification on seed germination has been studied in various plants.

Pathak, et al; 1974 **Kumari and Kohli,** 1984; **Gill et al;** 1986; **Newman,** 1989; **Rana and Nautiyal,** 1989; **Shrestha and Gautam,** 1989; **Crowley and Jackes,** 1990; **Ntumbula et al;** 1990; **Sehgal and Singh,** 1990; **Esenowo,** 1991; **Bhagat et al;** 1992; **Danthus, et al;** 1992; **Kalappa et al;** 1992; **Konstantinov,** 1992; **Ouattara and Louppe,** 1992; **Vaish et al;** 1992; **Omari,** 1993; **Reghunath et al;** 1993; **Snehlata and Verma,** 1993; **Bhardwaj and Chakraborty,** 1994; **Demel,** 1994; **Gill and Anoliefo,** 1994; **Gonzalez, et al;** 1994; **Brahmam et al;** 1996.

Effect of hot water, mechanical and chemical scarification treatments or breaking seed coat dormancy was reviewed by **Karihaloo,** (1984).

In *Terminalia bellerica* the seeds soaked in commercial sulphuric acid for 15 minutes gave maximum germination followed by cracking of seeds with one strokes of hammer (Sharma et al ; 1992). The enhanced germination of scarified (one punctured) seed of *Albizia lebbeck* indicate presence of seed coat dormancy (Khan and Tripathi, 1987). Similar observations has been made by earlier workers in other legumes (Mc Dowell and Moll, 1981). 88 and 92 percent germination was obtained when seeds of *Acacia albenda* and *Acacia nilotica* were soaked in sulphuric acid for 15 and 60 minutes respectively (Padma et al; 1992).

The acid treatment was very effective in improving seed germination in *Cassia fistula* (Randhawa et al; 1986). Dormancy in the seeds of *Vernonia galamensis* is caused by mechanical resistance their outer covering which restrict the enlargement and germination of the embryo (Teketay, 1993).

In *Dichrostachys cinerea* sulphuric acid pretreatment for 25 minutes was found to be effective by Roy et al; (1984). Scarification with sand paper (2 minutes) and chemical scarification with concentrated sulphuric acid (120 seconds) was judged to be the most effective method in breaking seed dormancy in Lentil (Singh and Tomar, 1992). Scarification with concentrated sulphuric acid (20 minutes) and nitric acid (10 minutes) also stimulate germination in *Acacia farnesiana* seed (Gill et al; 1986). Acid pretreatment also increase germination percentage in *Citrullus fistulosus* and *Glinus lotoides* (Harsh and Arora, 1994).

The effectiveness of different scarification treatment viz, acid, hot water and sand paper to overcome the hard seededness in copper pod tree (*Peltophorum ferrugineum*) and Subabool was studied by **Kalappa et al**; 1992). Acid scarification was to be provided for a longer duration to break seed coat dormancy. Acid scarification (conc H_2SO_4) of fresh seed of *Euphorbia dracunculoides* for 20 minutes yielded best germination (**Prasad**, 1992).

The effect of mechanical and chemical scarification in reducing the endocarp seed dormancy of Biul and the light mechanical scarification (2,3 hammer-stroke) was most effective for breaking seed coat dormancy (**Chauhan**, 1988).

The beneficial effect of soaking seeds with growth regulators has been studied by a great number of workers viz; **Ghouse, et al**; 1982; **Leadem**, 1987; **Eshana and Kulkarni**, 1990; **Thapliyal**, 1990; **Uanikrishnan and Rajeeve**, 1990; **Ferraz and Takakai**, 1992; **Moktan et al**; 1993; **Plyer and Carrick**, 1993.

Gibberellic acid (GA_3) application can break dormancy of lettuce seed as was reported by **Khan et al**; (1957) and **Mayer and Mayber** (1957) etc.

Pandya and Baghela (1973) reported that highest germination in *Celosia argentic* was obtained in GA_3 (5 ppm) IAA (10ppm). Concentration of IAA below 5 ppm and above 10 ppm retard the germination in that species. **Shukla and Baizal** (1977) found increased Indole acid oxidase activity under saline condition

which they attributed to be responsible for delay in germination and stunting the plant growth.

All the three growth regulators i.e., Gibberellic acid, Indole acetic acid and Indole butyric acid affected germination significantly as compared to control (**Singh et al;** 1992).

Auxins in high concentration generally inhibit germination. Gibberellins normally stimulate germination but in some cases it has been reported to inhibit seed germination (**Fujii et al;** 1960).

Gibberellins have been reported (**Atwater**, 1980, **Mayer** and **Mayber**, 1982; **Beweley** and **Black** 1985; **Richards** and **Beardsell**, 1987) to promote germination in seeds with rudimentary embryos, permeability barriers, mechanically resistant seed coat and these with germination inhibitor. Pregermination treatment with Gibberellic acid was envisaged to enhance the germination (**Maithani et al;** 1987). Indole acetic acid increased germination percentage in **Eulaliopsis** seed while Coumarin and Maleic hydrazide retarded it (**Yadav et al;** 1988). Coumarin can induce light sensitivity in varieties of lettuce seeds not requiring light for germination, as first shown by **Nutile**(1945). Coumarin and its derivatives are of fairly widespread occurrence in nature. The inhibitory action of Coumarin has been studied on a wide variety of seeds and it has usually been found to inhibit germination. A few isolated instances of stimulation of germination by Coumarin at very low concentration are however known (**Mayer** and **Mayber**, 1982).

Molisch, (1937) coined the term allelopathy and referred to it as biochemical interactions between all types of plants including microorganisms and considered both the detrimental and beneficial reciprocal biochemical interaction.

The term allelopathy has subsequently been referred to only harmful effect of one plant on another through production of specific chemicals by **Rizvi and Rizvi** (1986).

Different parts of a plant may contain different concentration of inhibitors which may effect seed germination and seedling growth. The effectiveness depends on the concentration of extract and the organ from which the extract has been prepared, (**Mall and Dagar**, 1979).

Extracts from root and shoot of early vegetative stage and inflorescence of reproductive stage of ***Parthenium hysterophorus*** were found to relatively more inhibitory as compared to extracts of root and shoot of late vegetative and reproductive stages on seed germination and seedling growth of both ***Phaseolus aureus*** and ***Triticum aestivum*** (**Agrawal and Anand**, 1989).

Bhardwaj (1993) observed decrease in germination percentage and growth of shoot and root in ***Zea mays*** as affected by leachate treatments.

Jadhav and Gaynar (1994) studied the effect of leaf leachate of *Tectona grandis* on rice and cowpea and reported that germination percentage was reduced significantly in early stages (3 days) but less in later stages of both the plants (11 days).

Mall and Dagar (1979) reported inhibitory effect of *Parthenium hysterophorus* extracts in *Zea mays*, *Sorghum vulgare* and *Cajanus cajan*. Inhibitory effect of *P. hysterophorus* extract has also been reported in *Brassica compestris* (Kumari et al; 1986), *Arachis hypogea*, *Crotolaria juncea*, *Phaseolus munga* (Sharma et al; 1977).

The allelopathic effects of *Digera muricata* on seed germination and seedling growth rate of groundnuts cv TMV2 were investigated by **Suseelamma and VenkataRaju** 1994. They found that 5-10% concentration of leaf inflorescence, stem and root extract of *D. muricata* significantly inhibited seed germination of groundnuts.

MATERIALS AND METHOD

The seeds of *Vitex negundo* were collected from Chandpura forest Orchha District Tikamgarh (M.P.). For germination experiments seeds were surface sterilized by keeping them in freshly prepared 0.1% mercuric chloride solution for 3 minutes and then rinsed thoroughly in distilled water. The standard conditions were used for

all germination test. The germination studies were conducted in petridishes on whatmann germination blotter paper, soaked with distilled water. All experiments were carried out in the Ecology laboratory of Bipin Bihari Mahavidhyalaya Jhansi.

The germination counts were done upto 30 days. Protrusion of radicle was taken as an indication of germination and the germination counts were recorded daily. In each petridish 25 seeds were kept and four replicates were maintained.

GERMINATION VALUE

The germination value was calculated as following : (Czabator, 1962)

$$GV = MDG \times PV$$

where, GV = Germination Value

MDG = Mean daily germination, and

PV = Peak Value

GERMINATION ENERGY PERCENTAGE

Germination energy percentage = $SG/TS \times 100$

Where, SG = Number of seeds germinated upto the peak germination period.

TS = Total number of seeds in a sample.

Most of the experiments were carried out to understand various factors which can be held responsible for germination process in *V.negundo*. These are as under -

- (I) Imbibition.
- (II) Seed size and weight.
- (III) Light quality and quantity.
- (IV) Acid scarification.
- (V) Mechanical scarification.
- (VI) Phytohormones
- (VII) Interaction with aqueous extracts of leaf, stem and inflorescence of *V.negundo*.

(I) Imbibition

Surface sterilized and thoroughly washed seeds of *V.negundo* were placed in beaker containing distilled water for 3,6,12,18,24,36,48 & 72 hours for imbibition at room temperature.

The imbibed seeds were placed in moist sterilized blotter papers for germination at room temperature ($20.5 \pm 2^{\circ}\text{C}$). For control unimbibed seeds were used.

(II) Seed Size And Weight

Normally the seed health governs the seed coat dormancy germination and early seedling growth in most of the seeds. Seeds collected from Chandpura forest, were subjected into nine categories.

300 seeds (3 replicates of 100 seeds each) were weighed individually on chemical balance and their size were measured by vernier alipers. Considering both weight and size the seeds were finally classed into nine polytypes -

Light weighted - Small sized. (0 - 0.0100 gm) & (0 - 0.0850 cm²)

Light weighted - Medium sized - (0.0850 - 0.1000cm²)

Light weighted - Large sized - (<0.1000 cm²)

Middle weighted - Small sized (0.0100-0.0150 gm) -

Middle weighted- Medium sized - -

Middle weighted- Large sized - -

Heavy weighted - Small sized (>0.0150 gm) -

Heavy weighted - Medium sized - -

Heavy weighted - Large sized - -

Seeds of these nine weight size classes were kept separately in petriplates containing moist blotter paper. The petriplates were placed at room temperature, ($21.4 \pm 1.9^{\circ}\text{C}$) and germination behaviour was recorded.

(III) Light Quality And Quantity

To evaluate the effect of light on germination, seeds were presoaked in distilled water for 24 hours, and were placed on moist blotter paper in petridishes. Some of the petridishes were maintained in wooden cabinet for complete darkness, few in shaded place and rest in different monochromatic light viz; Red, Blue, Green, White & Infra monochromatic lights were obtained by wrapping the petridishes with cellophane papers of desired colour.

Infra red light was used in two ways :- in first case the red cellophane paper was kept on top of a blue cellophane and in second case the blue cellophane paper was placed on top of a red cellophane. For white light, colourless transparent cellophane paper was used. Light was supplied by 100 watt electric bulb, which was kept 70 cm above the petridishes. Experiment was conducted at room temperature.

(IV) Acid Scarification

The seeds were directly immersed in concentrated sulphuric acid for different durations viz; 1 min, 2 min, 5 min, 10 min and 15 minutes and were stirred frequently with a glass rod. Treated seeds

were washed thoroughly in running water, so as to remove all the traces of acid and were soaked in ground water for 48 hours. Untreated seeds were used as control. The seeds were kept at $22.4 \pm 1.2^{\circ}\text{C}$ for germination.

(V) Mechanical Scarification

For testing the effect of mechanical scarification, seeds were subjected to stroking of hammer. Two treatments were adopted -

(a) one stroke

(b) two strokes.

Stroked seeds were soaked in distilled water for 24 hours at room temperature. Unstroked seeds were used as control with same manner of soaking. The experiment was conducted in lab at $22.4 \pm 1.2^{\circ}\text{C}$ temperature.

(VI) Phytohormone

Seeds were soaked for 24 hours in the aqueous solutions of Indole acetic acid, Gibberellic acid, Maleic hydrazide and Coumarin each at two concentration viz, 10 and 100 ppm. Combinations of Indole acetic acid and Gibberellic acid were also used viz, IAA + GA₃ (10ppm + 10ppm), IAA + GA₃ (10ppm + 100ppm), IAA + GA₃ (100ppm + 10ppm), IAA + GA₃ (100ppm + 100ppm). Seeds soaked in distilled water for same period were considered as control. They were

(VII) Interaction With Aqueous Extracts Of Leaf, Stem^{and}/Inflorescence
Of *V.negundo*.

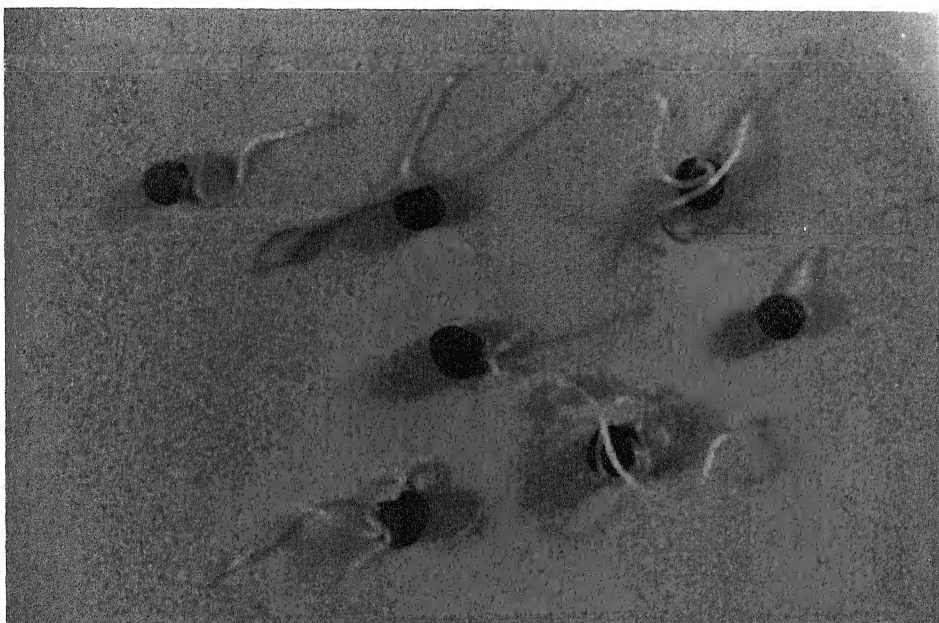
The aqueous extract of 10%, 50% and 100% concentration leaf, stem and inflorescence (dry parts were used) of *V.negundo* were separately prepared in distilled water (1:10 W/V ratio) 24 hours. Each of the extracts was filtered through Whatmann paper and the volume was made upto 100ml. This extract was considered as absolute solution. 50% and 10% solution was prepared by further dilution of the absolute solution.

Seeds of *V.negundo* were soaked for 24 hours in each of the prepared solution. For control seeds were soaked in distilled water for the same period. Soaked seeds were washed thoroughly with running water and were kept for germination in sterilized petridishes.

RESULTS AND DISCUSSION

During observation under different experimental conditions, where the seed failed to germinate, or exhibited low percentage of germination, dormancy and or non-viability was suspected^e to be the cause of such germination failure. To overcome such dormancy, and

PLATE - 3 : The aberrant and the normal seedlings
of *Vitex negundo* Linn.



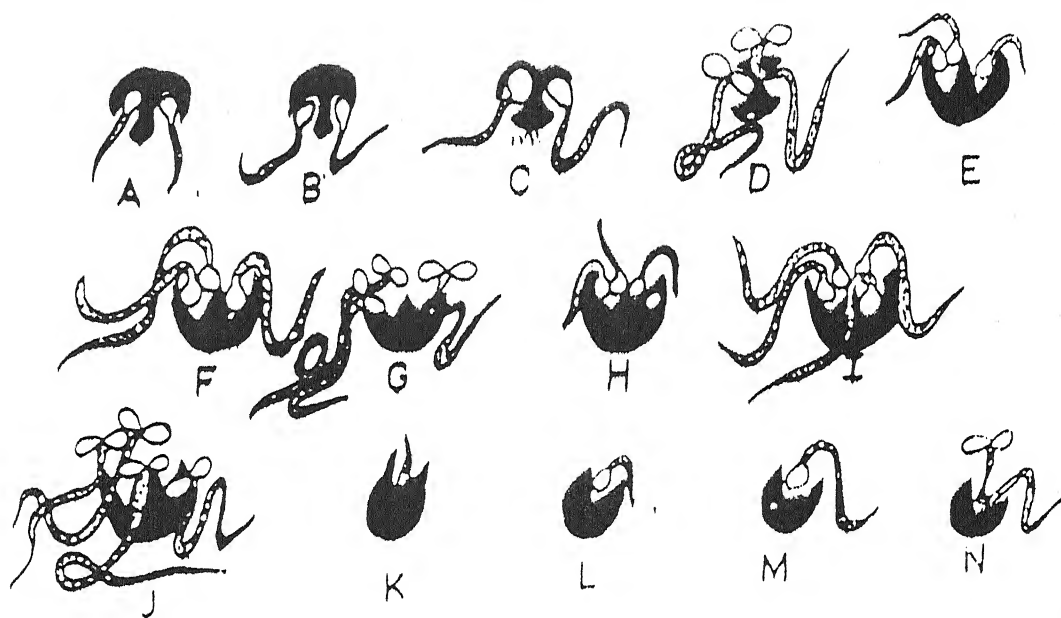


Figure 6.1 Germination style of twin (A-D), trin (E-G), tetra (H-J) and normal (K-N) seeds of *Vitex negundo* Linn.

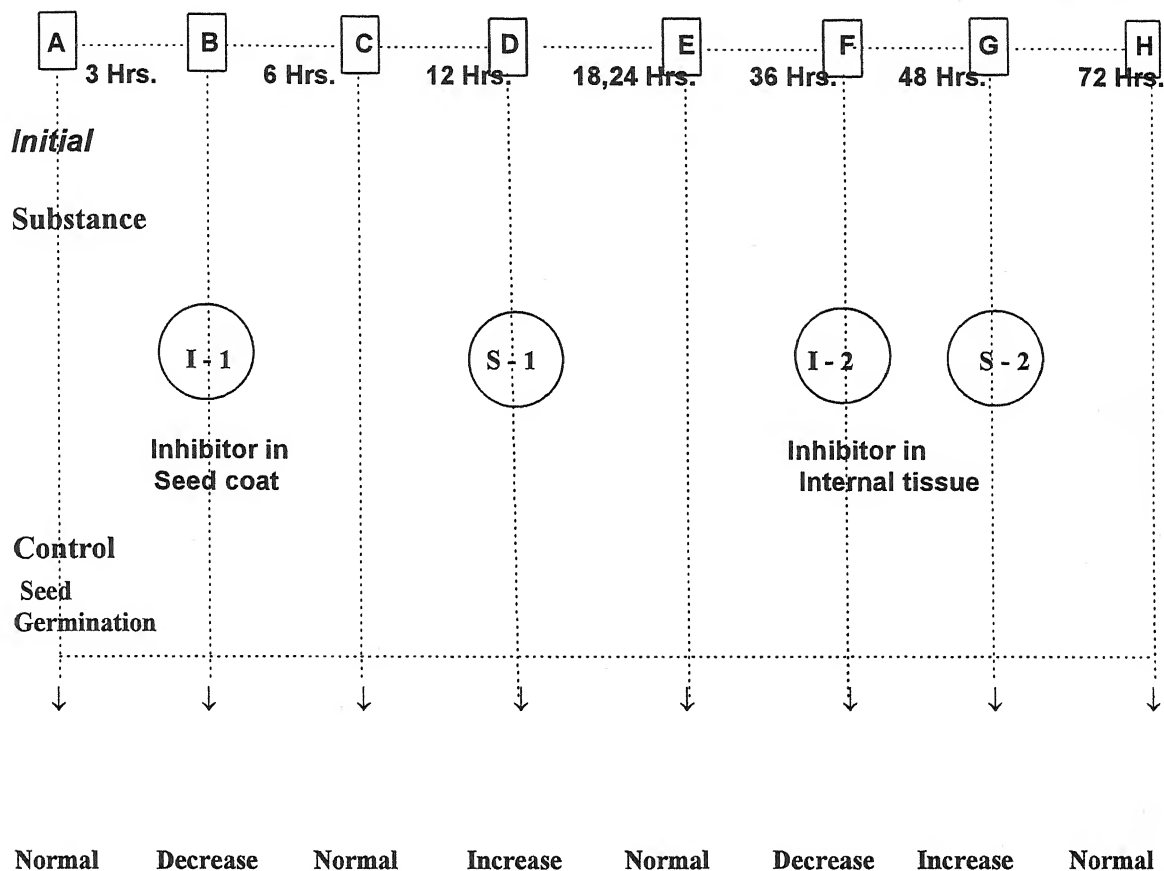
to achieve maximum of germination, number of treatments were attempted.

Resumption of active growth in embryo resulting in the rupture of seed coat and emergence of young plant is known as germination. The results obtained from various germination methods are provided in Table 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7.

During germination studies, abnormal seedlings were also recorded (**Bhatt and Saxena, 1995**). The abnormal seedlings were twin, trin and tetra containing two, three and four plumules respectively. Such abnormal seedling in *V.negundo* were observed probably for the first time. The style of germination (both normal and abnormal) is depicted in Fig-6.1

(I) Imbibition

The data of germination as affected by imbibition are presented in Table 6.1 and Fig 6.2. The perusal of table suggest that germination is affected by duration of soaking. Increase in soaking duration gradually increased the germination percentage upto some limit, but further the germination percentage fluctuated. Soaking of seeds for 48 hours duration showed significantly higher germination percentage in comparison to other durations of soaking. Minimum germination was obtained when seeds were soaked for 36 hours.



PROPOSED SCHEME OF A INHIBITION AND STIMULATION OF GERMINATION PERCENTAGE OF VITEX NEGUNDO LINN. SEEDS AS INFLUENCED BY DURATION OF SOAKING.

TABLE 6.1: Effect of imbibition on germination percentage of *Vitex negundo* L. seeds.*

Character	Duration of imbibition (Hours)								
	3	6	12	18	24	36	48	72	Control
Percent	0.75	1.00	2.00	1.00	1.00	0.50	3.00	1.00	1.00
Germination	(4.30)	(4.90)	(8.13)	(4.90)	(5.74)	(2.87)	(9.97)	(4.06)	(4.06)
SEm±=2.15					C. D. _{0.05} =4.4				

Angular values are in parenthesis.

SEm = Standard error of mean

C.D. = Critical difference

* 4 replicates of 25 seeds each.

TABLE 6.2: Effect of seed size and weight on germination percentage of *Vitex negundo* L. seeds.*

Character	Seed character								
	LS	LM	LL	MS	MM	ML	HS	HM	HL
Percent	2.75	3.00	0.75	4.75	4.75	3.75	0.50	2.00	0.75
Germination	(9.51)	(9.97)	(4.30)	(12.57)	(12.57)	(11.57)	(2.87)	(8.13)	(4.30)
SEm± = 1.28					C. D. _{0.05} = 2.64				

Angular values are in parenthesis.

SEm = Standard error of mean

C.D. = Critical difference

* 4 replicates of 25 seeds each.

Legends : LS=Light weight - Small sized MS=Middle weight - Small sized
 LM=Light weight - Medium sized MM=Middle weight-Medium sized
 LL=Light weight - Large sized ML=Middle weight - Large sized
 HS=Heavy weight - Small sized HM=Heavy weight-Medium sized
 HL=Heavy weight-Large sized

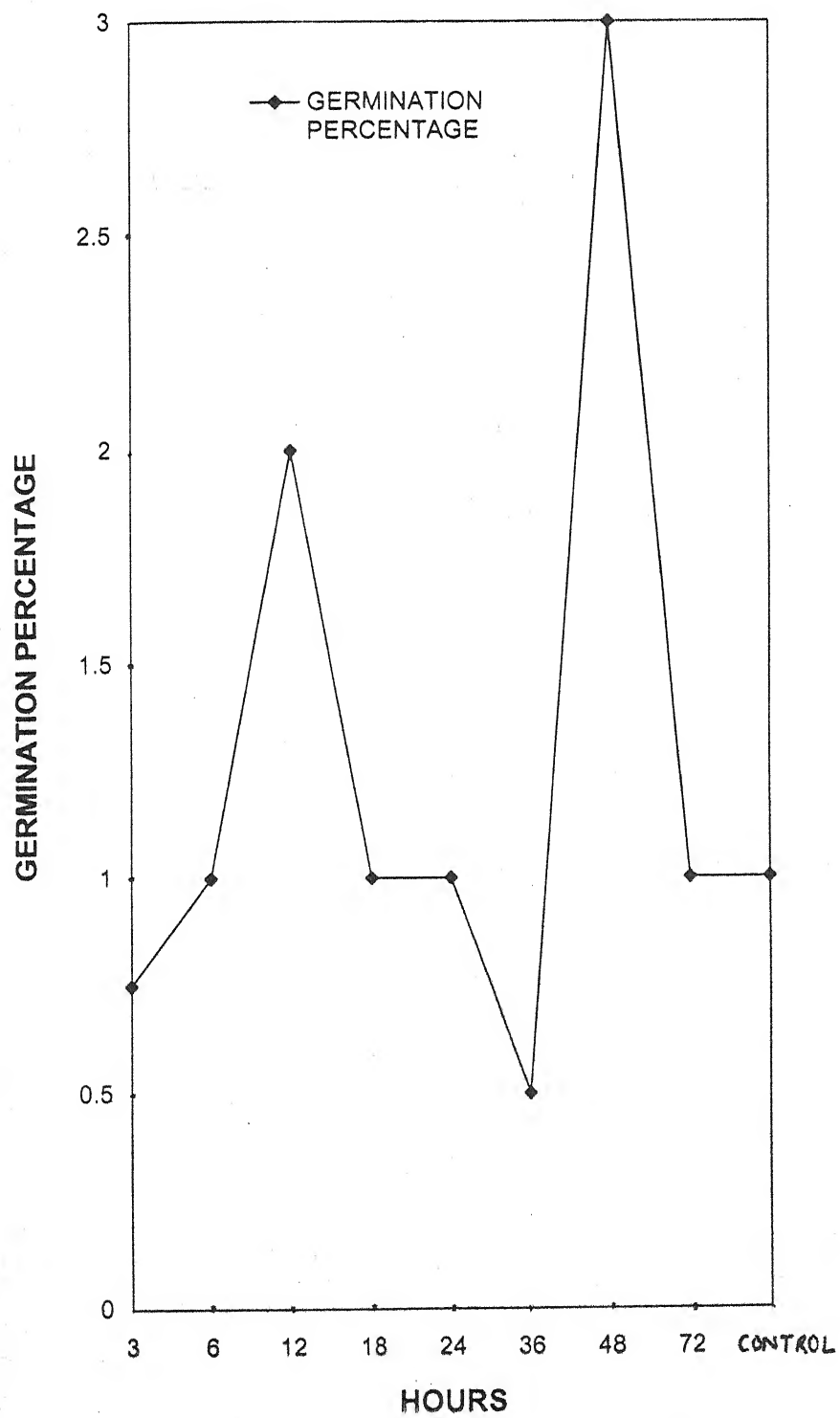


Figure 6.2 Germination percentage of seeds as affected by duration of imbibition.

The relationship between the amount of water absorbed and commencement of germination by radicle protrusion (as indicates would) show that atleast a period of 48 hours, imbibition was required to obtain maximum germination in this spp. During soaking imbibitional pressure develop in seeds which may lead to the breaking of seed coat thus, initiating the process of germination by **Mayer and Mayber 1982**).

Different duration of imbibition effect the germinative capacity of seeds, which can be attributed to the increased hydration initiating metabolic activities in the embryo of seed.

During imbibition, the seed develop its metabolic systems necessary for growth and enzymic components of these systems as well. Enzymes may arise from two sources they may be either released or activated from existing proteins, or synthesised a new through the nucleic acid directed protein synthesis (**Leopold and Kriedemann, 1975**).

In the present study it seems that initial stages of imbibition (3 hours) the seed coat might have released some chemicals. These chemicals behaved as inhibitory factors (I-1) which decreased the seed germination percentage. During soaking of seeds for more than 3 hours duration the inhibitory factor might have converted into some normal product of metabolism. Further soaking converted normal product into some stimulant (S-1) which stimulated germination percentage (12 hours).

During 18 and 24 hours of soaking the S-1 chemical becomes inactive. Thus germination percentage becomes normal.

In 36 hours of soaking the internal system of seed might have again produced some metabolic inhibitor (I-2), which further decreased the germination percentage. However more than 36 hours of soaking converted I-2 into S-2 (second stimulant) which triggered the percent germination. This S-2 product remains active for few hours. In absence of S-2 (72 hours soaking) the germination percentage again becomes normal. the chemical nature of both the inhibitors (I-1 & I-2) and stimulants (S-1 & S-2) is not known but it is presumed that they might be products of some enzymatic reactions.

(II) Seed Size And Weight

The data on germination as influenced by size and weight of seeds are presented in Table 6.2. It is evident from the results that maximum germination percentage was obtained in middle weight-medium sized and middle weight - small sized whereas minimum was recorded in Heavy weight - small sized seeds.

Germination of heavy seeds was very low in comparison to middle and light weighted seeds. The seed size revealed that there was significant variation in percentage germination but the middle weight - medium sized and middle weight - small sized seeds gave higher germination as compared to rest. Thus, results hint that

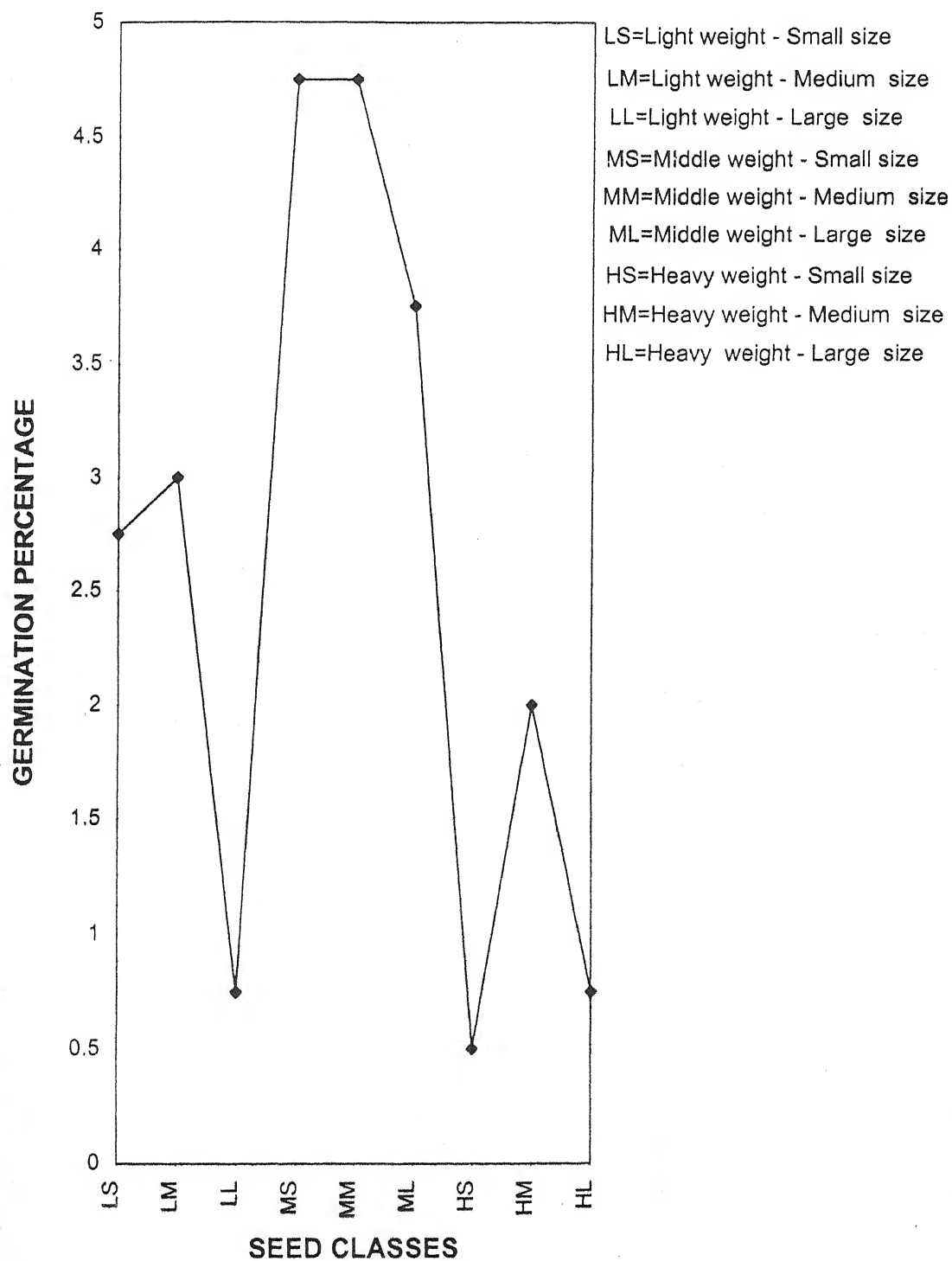


Figure 6.3 Germination percentage of seeds in relation to their size and weight.

germination percentage of various weight and size classes of seeds was in following descending order:-

$$MM = MS > ML > LM > LS > HM > HL = LL > HS \text{ Fig (6.3)}$$

The behaviour of polymorphic seeds during germination indicate that the seeds of middle weight -medium size and middle weight-small size gave maximum germination. This suggest that there was a natural adjustment with respect to the protection.

The size, shape, structure and composition of seeds can determine their germination behaviour in different environments. (**Mayer** and **Mayber** 1982)

It seems that size and weight ratio i.e. size/weight is the determining factor of germination in *V.negundo* Linn seed. The optimum S:W ratio initiates seed germination. Ratio lower or more than the optimum ratio of seed size and weight might be responsible for inhibiting germination process. Whether this proposed S:W ratio is influenced by any factor is not known.

(III) Light Quality And Quantity

The experiment conducted on the scarification of the seed gave ample evidence of the presence of seed coat dormancy which could be removed by variable doses of scarification either by light, hormone, acid or mechanical method.

The influence of light on germination of seeds is shown in Table 6.3 Fig. 6.4. The results indicate that the effect of white light was significantly higher in comparison to other light conditions. Maximum mean percentage of germination (13.5%) was recorded with white light followed by diffused light (12%). The minimum percentage of germination was observed when seeds were germinated in dark. The results indicated significant effect on percent germination. Red light is most effective amongst all other monochromatic lights for germination (11.75%).

Light is one of the important factors affecting seed germination. The importance of light as a factor in the germination of seed has long been recognized. The seed of *V. negundo* appeared to be photo sensitive. Such seeds supposedly possess inhibitors which are disintegrated by light. **Malik and Srivastava** (1979) has demonstrated that effect of light does not affect embryo.

Far red light is commonly known to inhibit germination and reverse the action of red light (**Kollar et al** 1964). It has also been pointed out by a number of workers :

(**Delint and Sprint** 1963, **Butler et al** 1964, **Siegelman and Firer** 1964, **Pratt and Briggs** 1966). These findings resemble with the present study.

It is possible that the light sensitivity of seeds has some relation to their germination in their natural habitat although such a view is contested by other (**Niethammer**, 1927).

TABLE 6.3: Effect of light conditions on germination percentage of *Vitex negundo* L. seeds*.

Character	Light conditions							
	Blue	Red	Green	White	Red +Blue	Blue +Red	Diffused light	Dark
Percent Germination	2.75 (9.51)	11.75 (20.02)	2.00 (7.99)	13.5 (21.54)	0.75 (4.30)	2.75 (9.44)	12.80 (20.26)	0.25 (1.43)
SEm \pm = 1.33				C. D. _{0.05} = 2.8				

Angular values are in parenthesis.

SEm = Standard error of mean

C.D. = Critical difference

* 4 replicates of 25 seeds each.

TABLE 6.4: Effect of sulphuric acid treatment on germination percentage of *Vitex negundo* L. seeds*.

Character	Duration of treatment (minutes)					
	1	2	5	10	15	Control
Percent Germination	3.5 (10.75)	6.25 (14.47)	7.25 (15.59)	5.00 (12.89)	5.57 (13.86)	2.25 (8.59)
SEm \pm = 0.68			C.D. _{0.05} = 1.5			

Angular values are in parenthesis.

SEm = Standard error of mean

C.D. = Critical difference

* 4 replicates of 25 seeds each.

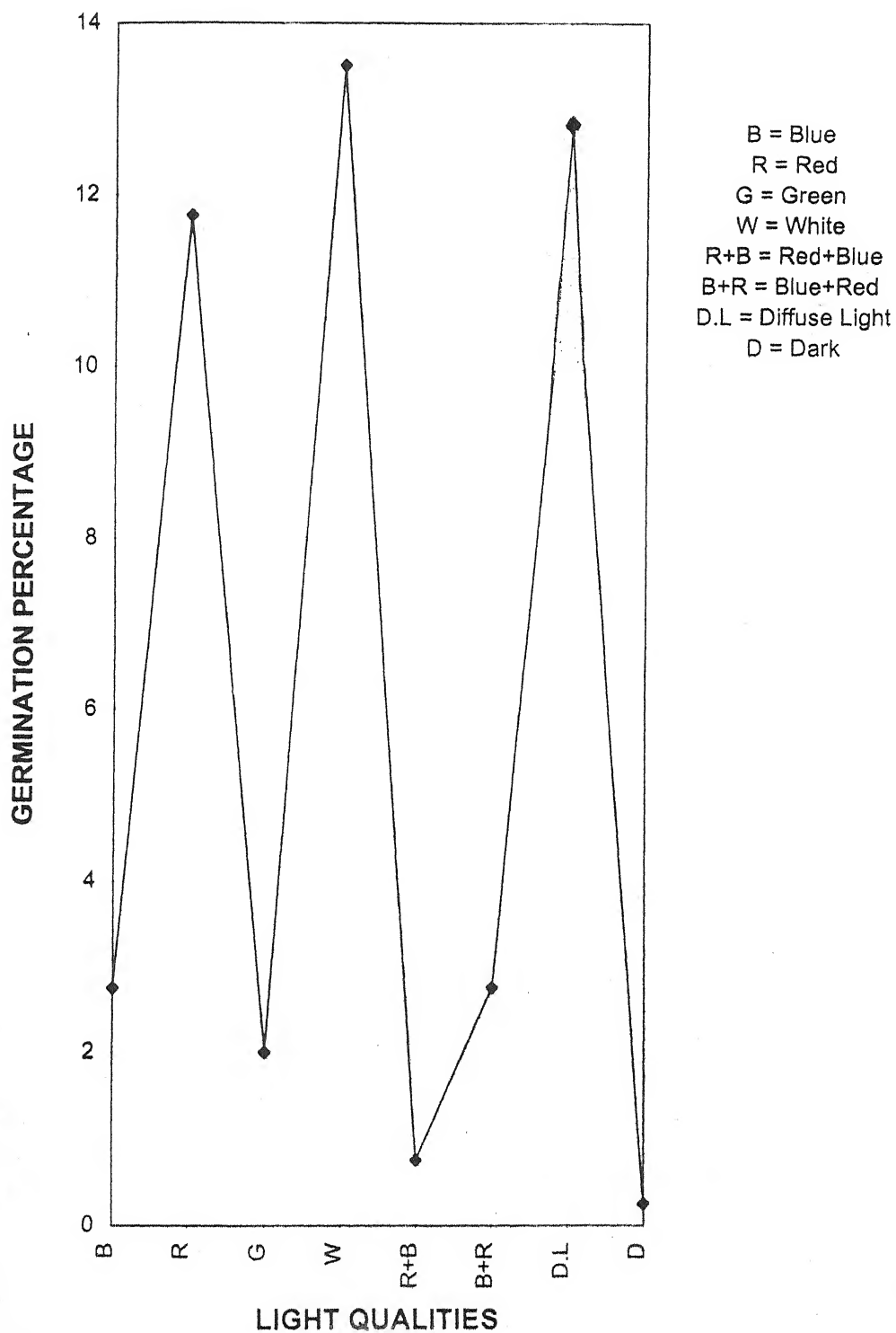


Figure 6.4 Germination percentage of seeds in relation to different light qualities.

(IV) Acid Scarification

For testing germinability of seeds having hard seed coat, acid scarification treatment was performed. Table 6.4, expresses the data regarding influence of duration of sulphuric acid treatment on germination manner of *V.negundo* seeds.

A soaking regimes of 5 minutes appears to be optimal. Duration of treatment for 1 minute or more than 5 minutes depressed germination capacity. Maximum mean percentage of germination (7.25%) was recorded with 5 minute scarification which is significantly higher than all other treatments. The results obtained were statistically significant except in 2 and 5 minutes treatment. Fig 6.5

(V) Mechanical Scarification

Results of hammer stroking are depicted in Table 6.5 & Fig 6.6. It is evident from the table that seeds stroked once show more germination than hammered twice or in control.

Maximum mean percentage of germination (5.0%) was obtained when seeds were stroked once followed by two stroke hammering (3.75%). The minimum mean percentage of germination was observed in control (3.0%). The results were found to be significant.

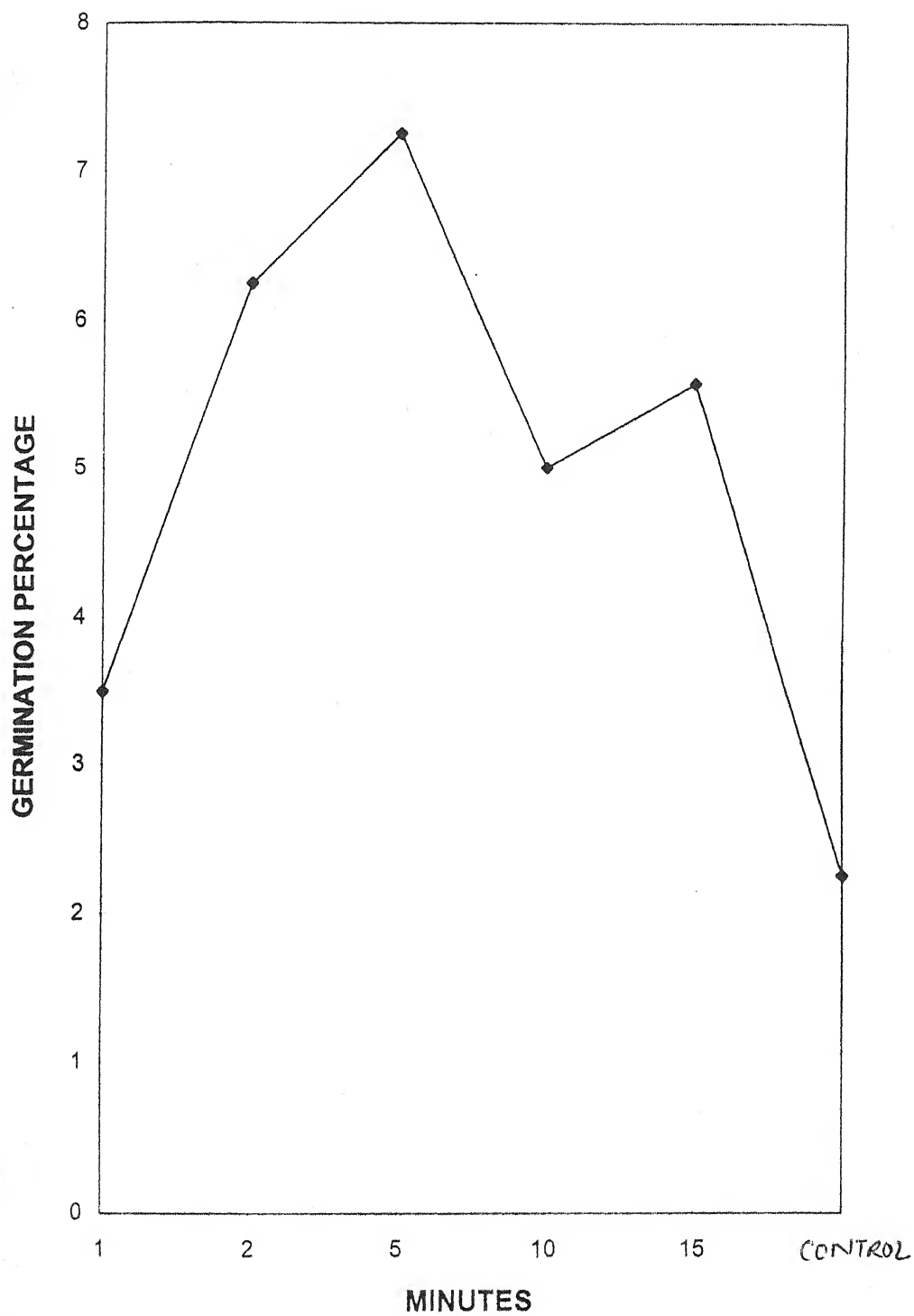


Figure 6.5 Effect of scarification on germination percentage of seeds.

TABLE 6.5: Effect of hammer strokes on germination percentage of *Vitex negundo* L. seeds.*

Character	Hammer strokes		
	Ones	Twice	Control
Percent	5.0	3.75	3.00
Germination	(12.92)	(11.15)	(9.90)
SEm \pm = 0.66			C.D. $_{0.05}$ = 1.6

Angular values are in parenthesis.

SEm = Standard error of mean

C.D. = Critical difference

* 4 replicates of 25 seeds each.

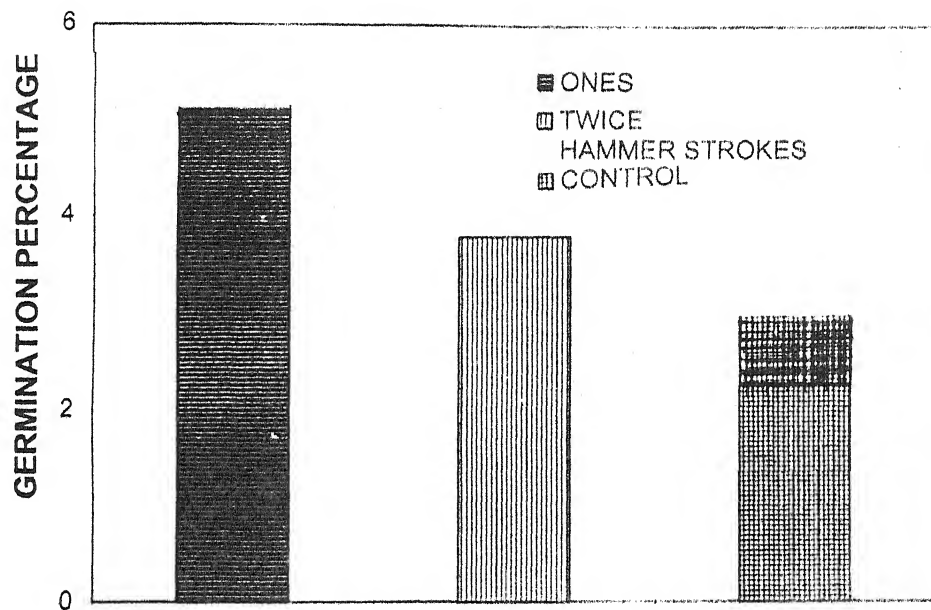


Figure 6.6 Effect of mechanical scarification on germination percentage of seeds.

A hard seed coat may be impermeable to either water or gases and can also prevent the leaching of inhibitors. The seed coat can be made permeable by using a stronger acid or by mechanical technique such as hammering.

As the duration of scarification was increased seed exhibited low germination indicating the possibility of embryo injury due to comparatively softer seed coat. However, in all the durations of treatments the germination percentage was higher than that of control. This suggest that some type of seed dormancy is certainly imposed by the seed coats of *V. negundo* seeds.

As in chemical scarification, mechanical scarification also break dormancy by weakening seed coat. Stroking of seeds once is more effective than that of stroking then twice. However, both the treatments enhanced the germination percentage in relation to control.

It seems that first light stroke is enough for cracking the seed coat so that the process of imbibition starts quickly and thus initates the process of germination. However the second stroke may impart some type of injury to the internal tissue of seeds.

(VI) Phytohormones

The data on germination as effected by some phytohoromes are presented in Table 6.6 & Fig. 6.7. The 100ppm concentration of IAA retarded the germinat^on whereas all other concentrations of IAA,

TABLE 6.6: Effect of some phytohormones on germination percentage of *Vitex negundo* L. seeds*.

Hormone percentage	Percent Germination	
IAA (10 ppm)	7.75	(16.06)
IAA (100 ppm)	5.00	(12.76)
GA ₃ (10 ppm)	11.75	(20.03)
GA ₃ (100 ppm)	18.00	(25.08)
IAA + GA ₃ (10ppm +10ppm)	16.00	(23.55)
IAA + GA ₃ (10ppm +100ppm)	17.25	(24.54)
IAA + GA ₃ (100ppm +10ppm)	18.25	(25.23)
IAA + GA ₃ (100ppm +100ppm)	18.25	(25.22)
COU (10 ppm)	5.25	(13.20)
COU (100 ppm)	5.25	(13.20)
MH (10 ppm)	5.25	(13.15)
MH (100 ppm)	5.50	(13.49)
Control	6.25	(14.27)
	SEm \pm =1.30	C.D. _{0.05} =2.65

Angular values are in parenthesis.

ppm =Parts per million SEm = Standard error of mean

C.D. = Critical difference

* 4 replicates of 25 seeds each.

Legends : IAA =Indole acetic acid GA₃ = Gibberellic acid
 COU = Coumarin MH = Maleic hydrazide

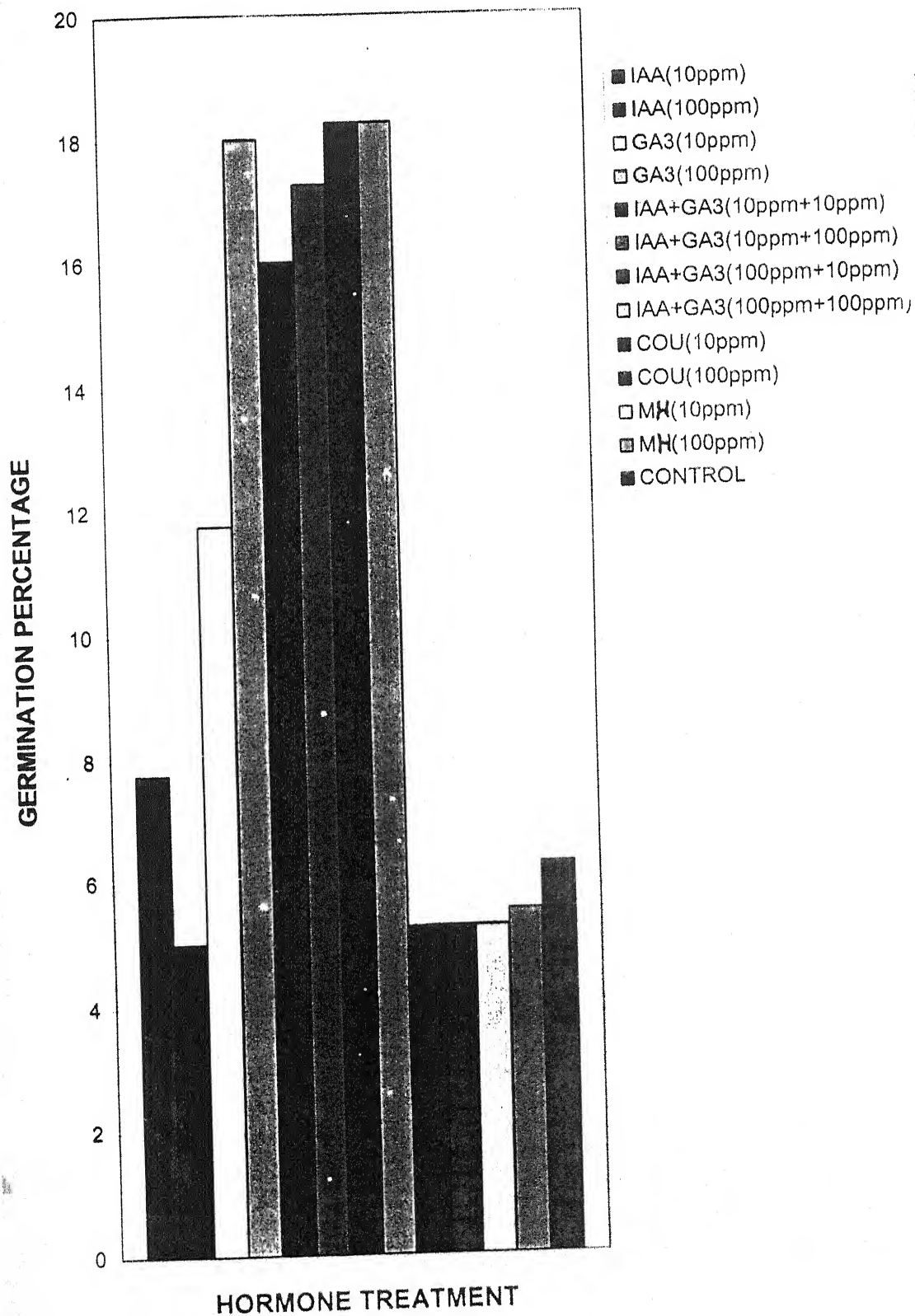


Figure 6.7 Germination percentage of seeds in relation to hormonal treatments.

GA₃ and their combinations more or less increased the germination percentage of seeds.

IAA+GA₃ at both 100 ppm + 10 ppm and 100ppm + 100 ppm concentration showed significantly higher mean germination percentage (18.25%) followed by IAA + GA₃ 10 ppm + 100 ppm concentration.

Various concentrations of Coumarin and Maleic hydrazide retarded the germination percentage of seeds in the present study.

The hormones affect germination behaviour when applied externally to imbibing seeds. Their metabolic products probably promote germination by acting as enzyme inhibitors.

The effect of IAA on germination has long been in dispute. Numerous workers have investigated the effect of IAA and similar substances on the germination of variety of seeds, and have obtained conflicting results, stimulation or inhibition being obtained depending on the concentration of IAA and the type of seed used. (Mayer and Mayber 1982).

Auxin in high concentration generally inhibit germination. Auxin are ordinarily not present in dry seed but are formed in early stages of germination process (Leopold and Kriedemann, 1975). These findings can be corelated with the present sutdy.

In seeds, germinated in Coumarin the lipids are not metabolized, because the seeds do not germinate. When germination is prevented with coumarin the rise in soluble nitrogen is prevented. This observation suggests that during normal germination and growth storage proteins are broken down and this breakdown is prevented by Coumarin, inhibit a proteinase present in ^{the} seed (Mayber 1953).

(VII) Interaction With Aqueous Extracts Of Leaf, Stem And Inflorescence Of *V. negundo*.

The effect of aqueous extracts of leaf, stem and inflorescence on germination of seeds is shown in Table 6.7 & Fig 6.8.

✓ The table indicate that the 10% concentration of leaf extract gave significantly higher mean germination percentage (4%) as compared to extract of other plant parts. The impact of inhibition increased with the increase in concentration of aqueous extract. ✓

At 10% and 50% extract concentration of stem the mean germination percentage was only 0.5%, whereas at 100% extract concentration no any seed could germinate. Similar results were obtained with inflorescence extract. At 100% concentration of inflorescence extract none of the seeds germinated however at 10% and 50% concentration of inflorescence extract mean germination percentage was 2% and 3% respectively.

TABLE 6.7 : Effect of aqueous extracts of litter on germination percentage of *Vitex negundo* L. seeds *.

Component of litter	Concentration of aqueous extract		
	10%	50%	100%
Leaf	4.00	3.00	2.00
	(11.49)	(9.97)	(7.02)
Stem	0.50	0.50	0.00
	(2.87)	(2.87)	(0.00)
Inflorescence	2.00	3.00	0.00
	(7.02)	(9.79)	(0.00)
Control	1.25	1.25	1.25
	(4.52)	(4.52)	(4.52)
SEm \pm	2.71	2.37	2.31
C.D. 0.05	6.13	5.36	5.22

Angular values are in parenthesis.

SEm = Standard error of mean

C.D. = Critical difference

* 4 replicates of 25 seeds each.

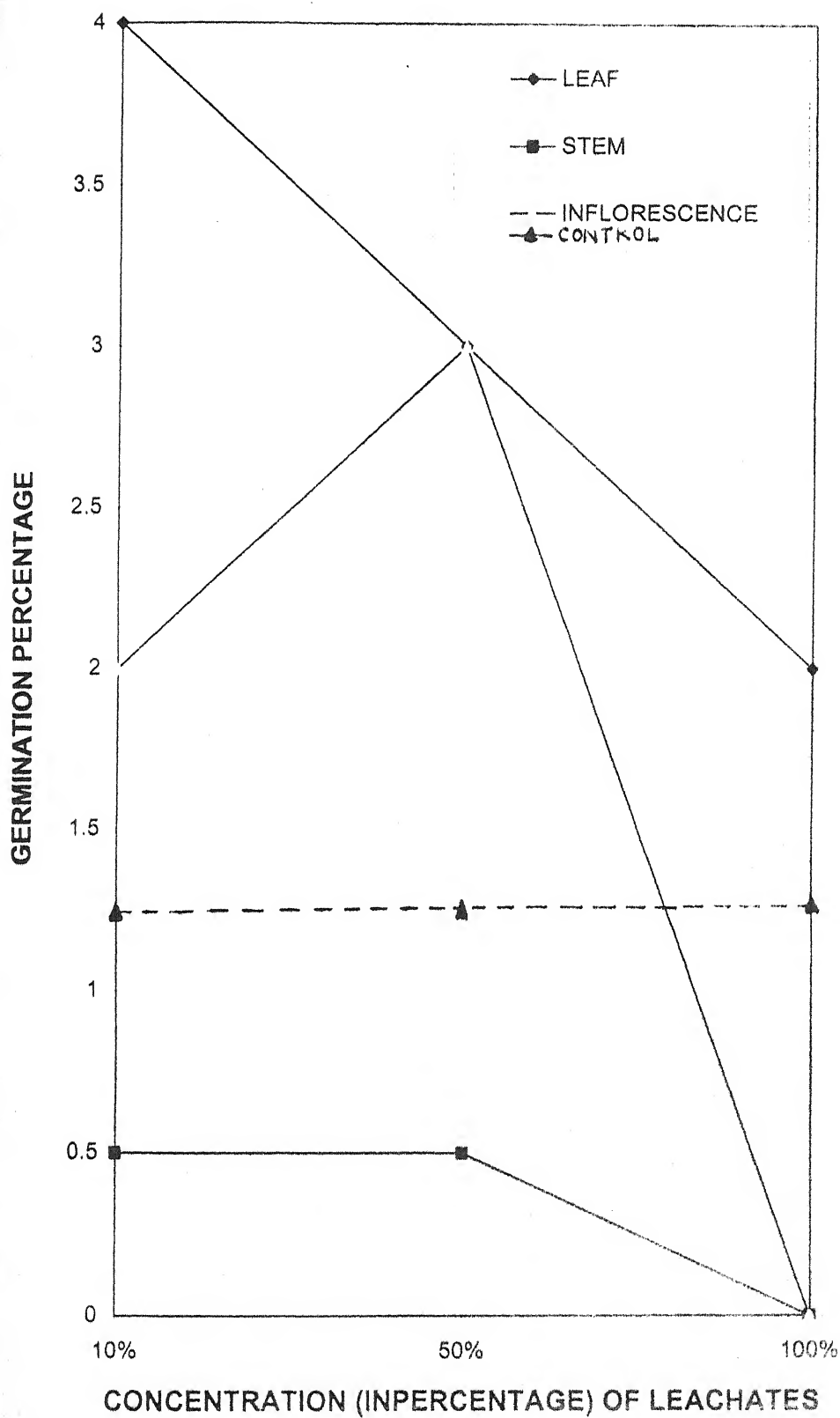


Figure 6.8 Germination percentage of seeds in relation to different concentration of leachates.

Insight of Table 6.7 reflects the fact that the aqueous extracts of leaf component enhanced germination percentage of seeds in all the three concentration. However, the enhancement decrease with subsequent increase in the concentration.

Maximum germination of seeds in all the three concentrations vis-a-vis all three aqueous extracts of litter components was achieved in leaf treatment. This indicates that some such chemicals are present in the leaf component of forest litter which not only initiates the processes of germination in *V.negundo* seeds but also triggers by providing some type of stimulus. The chemical nature of the same was however, not determined.

The effect of aqueous extract of stem component was detrimental which markedly inhibited seed germination in all the concentrations.

Aqueous extract of inflorescence component of forest litter enhanced the germination percentage when used in 10% and 50% concentration.

In 100% aqueous extracts of both stem and the inflorescence components of forest litter none of the seeds was germinated. This suggests that some inhibitors might be present in higher concentrations of stem and inflorescence components of which might have blocked the biochemical reactions necessary for germination.

From the above discussion it may be concluded that the germination of seeds is controlled by a variety of external and internal factors. These factors in addition to simple environmental conditions also include the presence of external and internal germination inhibiting and stimulating substances. One of the controlling factor is the balance between stimulatory and inhibitory concentration of the compounds at their site of action.

G R O W T H P E R F O R M A N C E**INTRODUCTION**

Seedlings represent the juvenile stage of plant life. They are very delicate and vulnerable to vagaries of nature.

Seedling phase is generally regarded as a phase in the life span of a plant between emergence of radicle from seed coat to the exhaustion of reserve food of the seed and onset of normal nutritional patterns with the plant (pelton, 1953).

Growth is an essential character of life and is by far the most complex of all the physiological processes. It has been established that the growth of one part of a plant tends to influence the growth and development of other parts.

While defining growth, two aspects—a permanent change in size and an increase in dry weight, appears quite reasonable to consider. When growth occurs plant organs increase in size and in their dryweight. Thus growth can be defined as “A vital process which brings about a permanent change in any plant or its part in respect to its size, form weight and volume.”

Moisture, nutrients and light are important factors which influence seedling growth and establishment. Growth of an organism indicates the suitability of the environment and the faculty of the organism to assimilate it into the body Components.

Variations in the growth performances of seedlings normally occur in relation to soil, water, light, growth hormones, fertilizers, manures etc.

Soil is an important factor in establishment and survival of a species. The growth and quality of forests, whether naturally occurring or artificially created, depends basically on the physical and nutrient status of the soil. Soil is a complex system consisting of varying proportions of two principal components. These are abiotic mineral or rock particle and the non living organic matter.

The second is biotic or living organism such as bacteria, fungi, algae, protozoa, insects etc. and small animals which directly or indirectly affect soil structure and the plant growth.

Distribution of vegetation over the surface of earth is controlled more by the availability of water than by any other single factor. The ecological importance of water is the result of its physiological importance. The only way in which an environmental factor such as water can affect plant growth is by affecting internal physiological processes and conditions. Almost every plant process is affected directly or indirectly by the water. A plant reaction to moisture stress embodies both physical and physiological component.

Growth regulations have attracted much attention in the recent years for check role in growth and development of plants. Internal differentiation of plants, initiation of cambial activity, xylem differentiation, annual ring formation etc. are also influenced by growth regulator (**Wareing et al**; 1964)

It is widely recognized that fertilizers can play an important role in increasing productivity through enhancing nutrient supply. Reports of increased growth of *Pines* due to fertilizers added to soil by broadcasting (**Richard**, 1956), in planting holes (**Barnes** and **Ralston** 1953; **Richard**, 1956) or by spray on the foliage (**Smith** and **Baytise** 1942; **Mckee**, 1976) are available.

REVIEW OF LITERATURE

The process of growth in plants start with the germination of seeds. It is governed by various factors eg. site conditions, availability of light, water, temperature and nutrient etc.

Basically growth of plants depend on soil for water and nutrient supply. **Naugraiya** and **Pathak**(1990) have reported that ***Atylosia scarabaeoides*** gave, maximum dry matter production in Black soil + sand (1:1) and minimum in pure sand. The effect of plant growth is not immediately depended on soil composition and texture which alter the soil physical properties (**O'Neil** and **Carrow**, 1982). In ***Eucalyptus camaldulensis*** obtained best results in sandy loam/clay soil at 1:1 or 2:1 composition. (**Alkinany** and **Alwady**, (1989). **Alkawaz** and **Alawi** , (1989) has reported that the best

medium for *Prosopis temarugo* seedling growth was loamy soil. The effect of different soil types available in Bundelkhand region viz, - Red, Black and a mixture of Red and Black on seedling growth of *Albizia amara* was studied by Roy, (1986). Of a number of soil factors, soil texture and soil moisture relationship have profound influence on root growth particularly in the seedling stage (Eavis and Payne, 1969).

A number of studies on different soil media in relation to seedling growth have been carried out by many workers : Shankar, 1970; Roy and Pathak, 1985; Awang and Hamzah, 1986; Bahuguna and Pyarelal, 1990; Beniwal and Dhawan 1991; Misra and Jaiswal, 1993.

Water is largely available and is essentially required for all activities of life. A plant reaction to moisture stress embodies both physical and physiological components. Al-Kawaz and Alawi, (1989) observed that irrigation interval significantly affect plant growth, except survival, with the best interval being one day.

The *Sporobolus pyramidalis* grew better when watered daily as compared to those when water was supplied twice or once a week (Sharma and Afolayan 1987). Once a day irrigation in *Albizia lebbeck* proved beneficial (Bahuguna et al, 1987). Naugraiya and Pathak, (1987) obtained the maximum shoot, root length in *Atylosia scarabaeoides* when irrigated alternately. But the maximum root, shoot dry weight were recorded at twice a day irrigation set. Vivek and Sharma, (1993) reported that the

irrigation did not show any significant effect on the yield of sunflower.

In *Anogeissus pendula* maximum dry weight was found in alternate day irrigation and the minimum growth of seedlings were observed in twice a week irrigation conditions (Tripathi and Saxena, 1986).

Much work on the relationship between soil water and plant growth was summarized by Richards and Wadleigh, 1952; Ruhland, 1956; Stanhill, 1957; Kramer, 1959; & 1963; Russel, 1959; Gardener 1960; & 1965; Taylor, 1960; Kozlowski; 1964; Pierre et al. 1965; etc. It appears that light intensity play an important role in the growth of plants. The quality of light, its intensity and duration influence germination, growth reproduction and movement of plants. Plant distribution is also very much affected by light.

Alysicarpus vaginalis exhibited fastest growth in full light while *A.monilifer* performed better under low light condition (Goel and Kumar, 1987). Sinha(1987) observed different light conditions viz.; full light,Partial shade and deep shade produced interesting effects on various growth parameters of three spp. of *Phyllanthus*. Quantitative response to day length with respect to flowering has been reported in Glycine max (Major et al 1975) and *Phaseolus vulgaris* (Zehni and Morgan,1976). Naylor ,(1953) has also reported that vegetative characters of plants are influenced by variation in daylight. A similar behaviour has been shown in *Eleusine indica* (singh, 1968) and *Melilotus indica* (Lavania , 1971).

The effect of light on growth performance of various plants were studied by - **Kasperbauer**, etal; 1963; **Mott** and **Mc Comb** , 1975 **sharma** and **Lavana**, 1977 and **Azad etal**; 1991. Hormones are chemical regulators , which acts as messangers for regulating various metabolic activities. In plants these chemical messangers are known as phytohormones .**Kumaran** etal., (1994) studied the effect of GA_3 , IAA, KN and CCC (chloro choline chloride) at 200 and 400 ppm on seed germination and seedling growth of ***Azadirachta indica***. The effect of IBA on the growth of ***Leucaena leucocephala*** was investigated by **Aderide** and **Oladele** (1991).

It is observed that GA_3 stimulate seed germination and seedling growth (**Khan etal .**, 1957 ;**Wittwer** and **Bukovae** , 1957 ; **Brain etal .**, 1962 ; & **Lolaraya** and **Rai** ; 1962).

In contrast to GA_3 effect ,coumarin exerted a marked inhibitory effect on both the seed germination and seedling growth. In ***Albizia adoratissima*** and ***Grevillea robusta*** though all growth regulators were positively effective than control but GA_3 (10ppm) was most promising amongst them (**Moktan etal.**, 1993). The application of lower doses of GA_3 (10ppm) in ***Tectona grandis*** and (15ppm) in ***Dendrocalamus strictus*** induced a promotive effect on growth and dry weight of shoot and root (**Misra** and **Misra** , 1984).

Naugraiya and **Pathak** , (1987) have reported that in lower concentration of GA_3 the various growth parameters viz. dry matter

production ,RGR , NAR , LAR were high whereas, high concentration gave a depressing effect.

Maleic hydrazide act as antiauxin and hence retarded the growth . Effect of Maleic hydrazide on germination and growth of seedling has been studied in *lettuce* (**sankhla** and **sankhla** ; 1968 ; **Mohan Ram** and **Mazumdar**, 1977). *Lycopersicon esculentum* and *Brassica oleracea* (**Jain**, 1978). Concentration of 50 and 100 ppm Maleic hydrazide promoted fresh weight and biomass of *Leucaena Leucocephala* seedling (**Minu** and **Murthy**, 1990). Root growth was decreased by coumarin because it is also considered as a natural inhibitor of root growth (**Yadav et al.**, 1988).

Fertilizers favour establishment and growth of plants. The application of nitrogenous fertilizers generally stimulate plant height and collar diameter in *Populus* under nursery and plantation conditions, (**Giulimondi** , 1961 ; & 1972 ; **Leroy**, 1969; **Blackman**, 1977 etc.) Good response were noticed by the application of NPK fertilizer in fast growing *Populus deltoides* and clones (**singh**, 1978).

The role of nitrogen to increase herbage yield and active contents has been well documented in many medicinal and aromatic plants viz,- *Mentha spp.* (**singh** and **singh** , 1979; **singh et al.**, 1979; **Bhardwaj, et al.**, 1980) and *Solanum laciniatum* (**Bardoloi et al.**, 1976).

NPK significantly increased total seedling biomass. In *Robinia pseudoacacia* the best response were observed in 375 mg N, 250 mg P and 250 mg K per plant (Bhardwaj et al., 1991). 100 ppm of nitrogen and P_2O_5 with 25 ppm K_2O gave best results in *Acacia nilotica* seedlings (Prasad and Rawat, 1991). Evans and Wildes, (1971); Agrawal, (1986) has reported that Potassium play an important role in activating enzymes, involved in wide range of processes including starch and protein synthesis. The direct involvement of Potassium in Photosynthetic phosphorylation has also been reported by suelter, (1970). Sagwal, (1990) has observed the best growth in *Acacia catechu* with N-75, P-37.5 treatments. Researches on various aspects of inorganic fertilizers have been carried out and are too numerous to be listed however some of them^{are}: Nandi and Chatterjee 1983 Singh et al., 1985; Sharma, 1989; Sanginga et al., 1991 Sidhu and Agrawal, 1992; Sundara raju et al; 1991; Everaarts, 1992; Gupta and Prasad, 1994; Singh et al; 1994; Thompson and Doerge 1996 a & b, etc.

Organic manures play important roles in soil. They directly affect plant growth. Naugraiya and Pathak (1990) has observed that the growth and productivity were maximum in Muram + Farm yard Manure (1 :1) and in pure farm yard manure the plants does not survive.

Effect of organic matter on plant growth has been reported in several instances, Beniwal and Dhawan 1991, Szott et al., 1991; Misra and Jaiswal, 1993; etc.

MATERIALS AND METHOD

The materials used and the techniques employed during field experiments are described as below :-

Experimental Design :-

The following experiments were designed for establishing growth performances :-

- (I) Soil composition,
- (II) Moisture regime,
- (III) Light condition,
- (IV) Phytohormones,
- (V) Inorganic fertilizers, and
- (VI) Organic manures,

(I) Soil Composition

The experiment was conducted in polythene bags 15 cm diameter and 23 cm height with different levels of soil composition, Viz,

- (A) Pure red,
- (B) Pure black,

- (C) Pure sand,
- (D) Red+Black 1:1),
- (E) Red+Sand (1:1),
- (F) Black+Sand (1:1) and,
- (G) Red+Black+Sand (1:1:1).

The seeds were sown in June, 1995 when the seedling were three months old. One plant per pot was maintained. Three replicates were managed and the pots were arranged in randomised block design. Pots were watered regularly to maintain their water status. Each set consisted of 15 pots.

After every two months interval, 3 pots per treatments were harvested (upto 6 months) for recording growth and dry matter production. Data of final harvest was analysed statistically and critical difference was calculated. The total dry matter production and leaf area at each harvest were used for computation of RGR, NAR and LAR as per formula.

(II) Moisture Regime

The experiment was conducted in polythene bags 15cm diameter and 23cm height filled with ordinary garden soils. Seeds were sown in September, 1994. About three months old seedlings were used to observe the effect of three different irrigation conditions, viz,

(A)Daily

(B)Alternate days

(C)Thrice in a week.

In each set 25 pots were arranged in randomised block design. One plant per pot was maintained. The experiment was carried out for six months. At two months interval five seedlings per treatment were selected randomly from each of the replicates and the growth parameters were recorded.

(III) Light Conditions

The experiment was conducted in polythene bags,15cm diameter and 23cm height filled with ordinary garden soils. Seeds were sown in December 1994 and three months old seedlings were carefully transplanted in these polythene bags. One plant per bag was maintained. For observing growth performance two light conditions viz.

(A)Full sunlight

(B)Diffused light (under tree canopy),

were used. In each set 15 pots were arranged and three replicates of each set were harvested after 2 month interval. During the experiment regular watering was done to maintain the optimum soil moisture.

(IV) Phytohormones

The experiment was conducted in polythene bags 23cm diameter 36cm height filled with ordinary garden soils. Seeds were sown in the month of July 1995. Raised (3 months old) and transplanted seedlings were used for the experiment. Aqueous solutions of various phytohormones viz; Indole acetic acid (IAA), Gibberellic acid (GA_3), Coumarin (Cou) and Maleic hydrazide (MH) were prepared afresh each in two concentrations of 10 and 100 ppm. Four combinations of IAA & GA_3 were also used. Total solutions of phytohormones including control are as below :-

- (A) IAA 10 ppm
- (B) IAA 100 ppm
- (C) GA_3 10 ppm
- (D) GA_3 100 ppm
- (E) IAA + GA_3 10 ppm + 10ppm
- (F) IAA + GA_3 10 ppm + 100 ppm
- (G) IAA + GA_3 100 ppm + 10 ppm
- (H) IAA + GA_3 100 ppm + 100 ppm
- (I) Cou 10 ppm
- (J) Cou 100 ppm

(K) MH 10 ppm

(L) MH 100 ppm

Test solutions were exogenously applied on the exposed part of the seedlings with the help of a glass sprayer. The fresh aqueous test solutions were sprayed at 2 months interval. Seedlings under control were sprayed with distilled water. All the sprayings were performed during late evening so as to check the detrimental effect of light on hormones. Seedlings were harvested after 3 and 6 months for computing their growth performances and biomass production.

(V) Inorganic Fertilizers

The experiment was conducted in polythene bags 23 cm diameter and 36 cm height. Nitrogen and phosphorus were given in measured amounts to the soil. Nitrogen was given in three doses at the rate of 60, 90 and 120 kg/ha in form of urea (MCC Laboratory chemicals). Phosphorus was given in two doses at the rate of 30 and 60 kg/ha in form of Single Super Phosphate.

Both the fertilizers were used in various combinations including control as listed below :-

(A) N_1P_0

(B) N_2P_0

(C) N_3P_0

(D) N_1P_1 (E) N_2P_1 (F) N_3P_1 (G) N_1P_2 (H) N_2P_2 (I) N_3P_2 (J) N_0P_1 (K) N_0P_2 (L) N_0P_0

Where N_0 = Without urea
 N_1 = Urea 60 kg/ha
 N_2 = Urea 90 kg/ha
 N_3 = Urea 120 kg/ha
 P_0 = Without phosphorus
 P_1 = Phosphorus 30 kg/ha
 P_2 = Phosphorus 60 kg/ha

Seedling were raised in nursery plots. At the age of three months the seedlings were carefully transplanted in the experimental bags. Phosphorus was added in soil at the time of transplantation, whereas nitrogen was given in two split doses one at the time of transplantation and the other after 30 days interval. The pots were regularly watered in order to maintain the optimum moisture level.

Total twelve sets of the treatments were planned including a control set. Each set consisted of 20 bags. At three months interval, five seedlings from each of the treatments were harvested randomly for recording their growth performances.

(VI) Organic Manures

The experiment was conducted in polythene bags 25cm diameter and 36cm height, filled with ordinary garden soils. The seeds were sown in nursery plots in July 1995 and were transplanted^a in polythene bags at the age of three months. Twenty five bags were managed in each of the eight treatments alongwith a control set. The following manures were added in soil for study

(A) Cow dung 20g/kg

(B) Goat faeces 20g/kg

(C) Poultry waste 20g/kg

(D) Bone meal 2g/kg

(E) Water hyacinth in form of dry powder 5g/kg

(F) Forest litter 5g/kg and

(G) Blood from slaughter house 3g/kg.

Each of the manures was mixed in 5kg soil per bag. One plant per bag as managed. Moisture level of soil was maintained by

frequent watering. After three months interval five plants per treatment were randomly harvested, for six months (Harvest I after three months and Harvest II after six months) for recording their growth performance and dry matter production.

OBSERVATIONS:-

The principal parameters which were employed for determining growth are as follows:-

(1) Total Plant Length

It was measured in centimeter and average of each treatment was recorded. The length was measured from distal root tip to the upper most stem tip.

(2) Collar Circumference

Collar circumference was measured in centimeter with the help of vernier calipers.

(3) Number Of Leaves

The green leaves of all the replicates per treatment were counted and the number of leaves per plant was recorded.

(4) Number of Lateral Roots

The number of lateral roots were simply counted.

(5) Leaf Area

The area of leaves per plant was determined in square centimeter by making use of a portable area meter (**Li Cor Model LI-3000**)

(6) Dry Matter Production

At each harvesting plant samples were carefully collected and were dried in oven at 80°C till constant dry weight was achieved. Growth may be regarded as an increase in dry weight or accumulation of biomass. The growth was analysed by computing RGR, NAR and LAR values as follows:-

Relative Growth Rate (RGR)

It is increase in weight per unit of original weight over a given interval of time.

$$\text{RGR} = \frac{\log_e W_2 - \log_e W_1}{T_2 - T_1}$$

Where W_1 = Dry weight of plant at time T_1 (starting time of experiment).

And W_2 = Dry weight of plant at time T_2 (finishing or harvesting time of experiment).

Net Assimilation Rate (NAR)

It is the rate of increase in dry weight per unit leaf area assuming that both dry weight and leaf area increase exponentially. Photosynthetic tissue other than leaves would of course be taken into account

$$NAR = \frac{(W_2 - W_1)}{(T_2 - T_1)} \times \frac{(\log A_2 - \log A_1)}{(A_2 - A_1)}$$

Where W_2 and W_1 is the total plant dry weight at a time T_2 and T_1 respectively where as A_2 and A_1 is the leaf area at time T_2 and T_1 respectively.

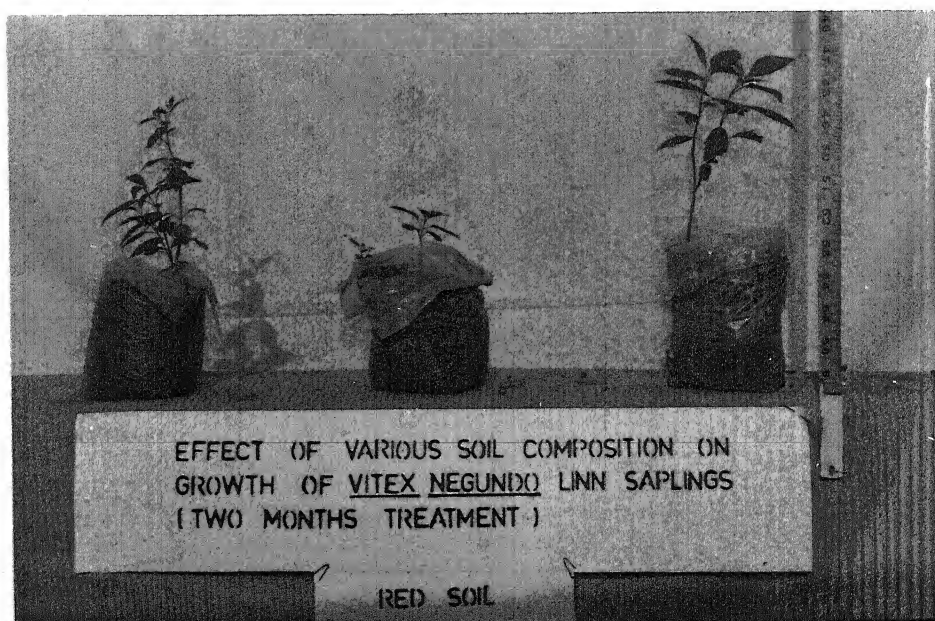
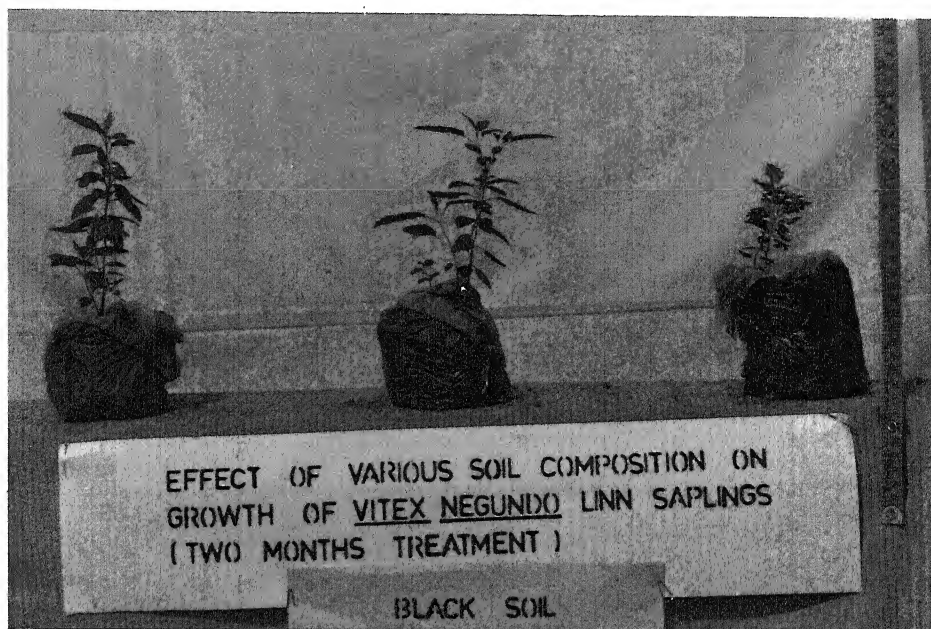
Leaf Area Ratio (LAR)

It is the ratio of leaf area to plant dry weight.

$$LAR = \frac{(A_2 - A_1)}{(W_2 - W_1)} \times \frac{(\log W_2 - \log W_1)}{(\log A_2 - \log A_1)}$$

Plate - 4 : BLACK SOIL : Effect of various soil composition on growth of *Vitex negundo* Linn sapling (Two month treatment).

Plate - 5 : RED SOIL : Effect of various soil composition on growth of *Vitex negundo* Linn sapling (Two month treatment).



RESULT AND DISCUSSION

The results of various treatments conducted for assessing growth performance of *Vitex negundo* seedlings are tabulated and discussed.

(I) Soil Composition

Soil is one of the most important ecological factor. Plants depend for their nutrients, water supply and anchorage upon the soil in which they grow.

soil consists of four fractions :-

(a) Mineral particles,

(b) Non-living organic matter, both of which form the matrix,

(c) Soil solution, and

(d) Soil air, both of which occupy available pore space within the matrix. The establishment and growth of plants in any given habitat largely depends on the soil type, which also influences the growth and functioning of roots.

Plant Growth Performance

The perusal of Table 7.1 fig 7.1 indicates that maximum plant length was obtained in pure sand, whereas minimum was obtained in a composition of Red Soil + Black soil (1:1). Collar circumference

Table 7.1 Effect of various combination of different soil compositions on total length (cm) of *Vitex negundo* L. seedlings*.

Soil Compositions	Seedlings harvested after		
	2 months	4 months	6 months
Pure Black	23.23	30.10	38.50
Pure Red	28.04	31.83	38.23
Pure Sand	39.83	48.33	57.50
Black+Sand (1:1)	22.50	27.00	38.50
Red+Sand (1:1)	24.87	28.50	34.67
Red+Black (1:1)	20.67	22.50	30.20
Red+Black+Sand (1:1:1)	22.23	27.67	34.83
SEm \pm	0.96	1.31	1.16
C.D. _{0.05}	2.09	2.85	2.54

* Average of 3 plants per treatment

SEm = Standard error of mean

C.D. = Critical difference

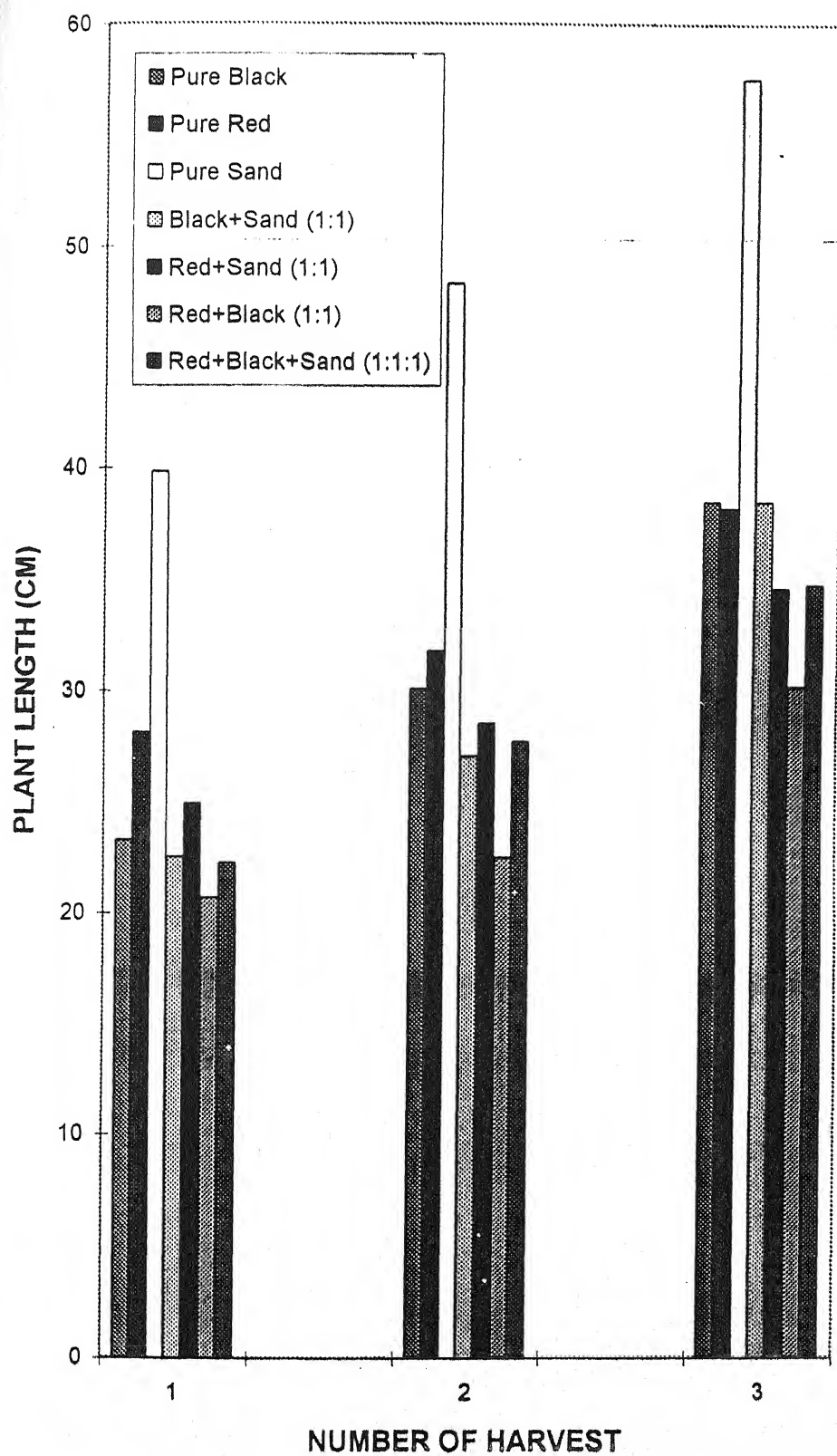


Figure 7.1 Total plant length of *Vitex negundo* seedlings under different soil composition.

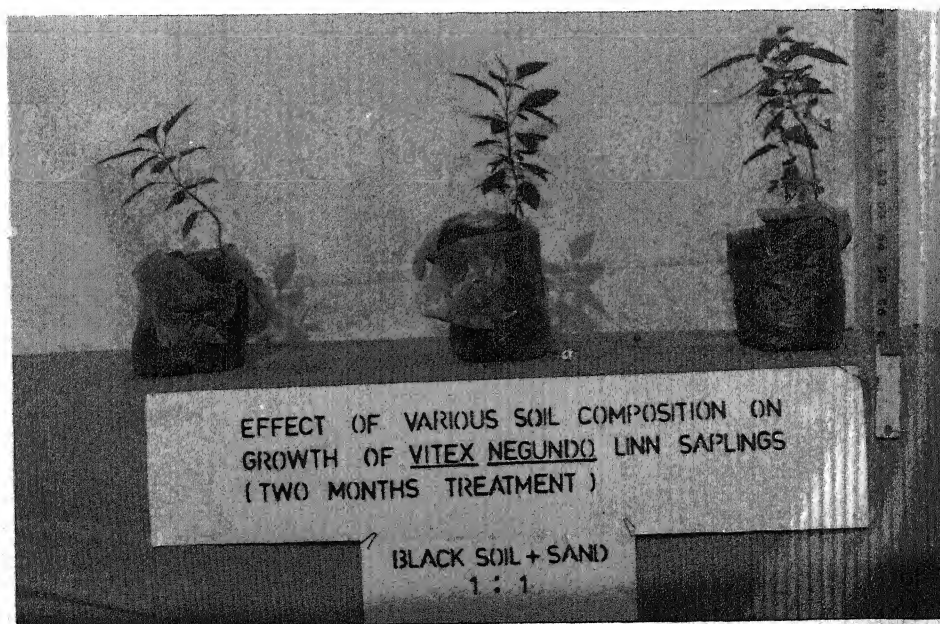
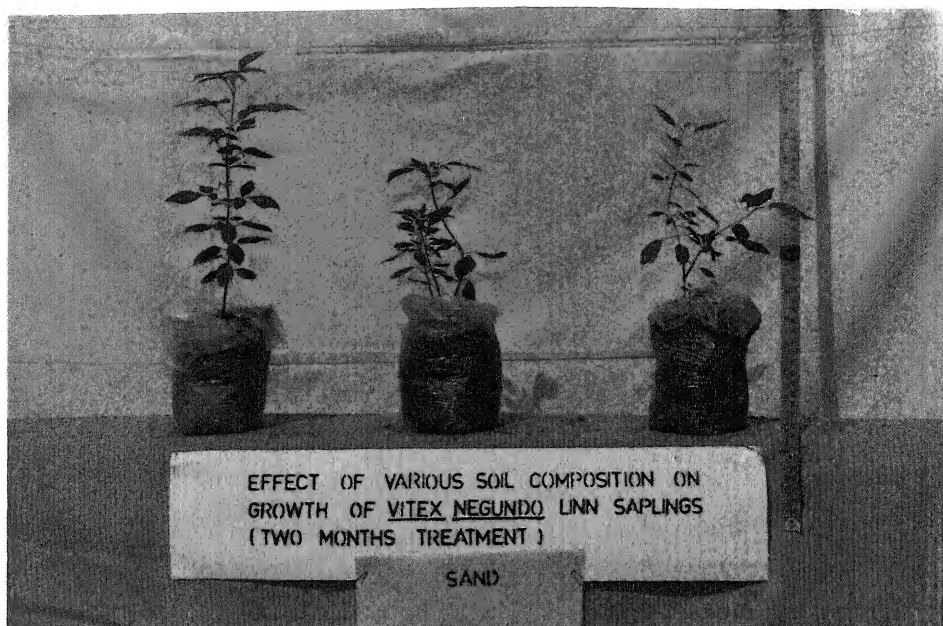


Table 7.2 Effect of various combinations of different soil composition on collar circumference (cm) of *Vitex negundo* L. Seedlings*.

Soil Composition	Seedlings harvested after		
	2 months	4 months	6 months
Pure Black	0.63	0.87	1.10
Pure Red	0.80	1.03	1.13
Pure Sand	1.13	1.30	1.50
Black+Sand (1:1)	0.70	0.87	1.20
Red+Sand (1:1)	0.57	0.90	1.03
Red+Black (1:1)	0.57	0.67	0.93
Red+Black+Sand(1:1:1)	0.70	0.97	1.13
SEm \pm	0.04	0.06	0.06
C.D. _{0.05}	0.09	0.14	0.14

* Average of 3 plants per treatment

SEm = Standard error of mean

C.D. = Critical difference

Table 7.3 Effect of various combinations of different soil compositions on number of lateral roots of *Vitex negundo* L. Seedlings*.

Soil Compositions	Seedlings harvested after		
	2 months	4 months	6 months
Pure Black	12.30	22.67	26.00
Pure Red	19.30	23.67	26.30
Pure Sand	29.00	36.00	40.33
Black+Sand (1:1)	12.00	21.33	27.30
Red+Sand (1:1)	20.00	20.67	28.33
Red+Black (1:1)	13.30	15.00	17.00
Red+Black+Sand(1:1:1)	17.30	21.66	24.00
SEm \pm	0.96	0.90	0.85
C.D. _{0.05}	2.09	1.95	1.86

* Average of 3 plants per treatment

SEm = Standard error of mean

C.D. = Critical difference

Table 7.4 Effect of various combinations of different soil compositions on number of leaves and leaf area (cm²) of *Vitex negundo* L. Seedlings*.

Soil composition	Seedlings harvested after					
	2 months		4 months		6 months	
	Leaves		Leaves		Leaves	
	Number	Area	Number	Area	Number	Area
Pure black	13.33	29.80	25.67	47.81	27.67	53.05
Pure red	23.00	43.94	24.33	73.22	29.33	75.19
Pure sand	26.00	77.96	32.00	97.49	38.33	168.74
Black+Sand (1:1)	15.00	29.99	15.33	30.24	29.00	103.85
Red + Sand (1:1)	12.67	20.62	21.67	32.04	23.67	43.40
Red+Black (1:1)	10.67	11.12	16.67	14.73	20.33	24.84
Red+Black+Sand (1:1:1)	18.33	27.71	26.00	57.93	26.67	81.12
SEm \pm	1.04	1.04	1.17	0.68	0.94	0.71
C. D. _{0.05}	2.27	2.26	2.55	1.49	2.05	1.56

* Average of 3 plants per treatment

SEm = Standard error of mean

C.D. = Critical difference

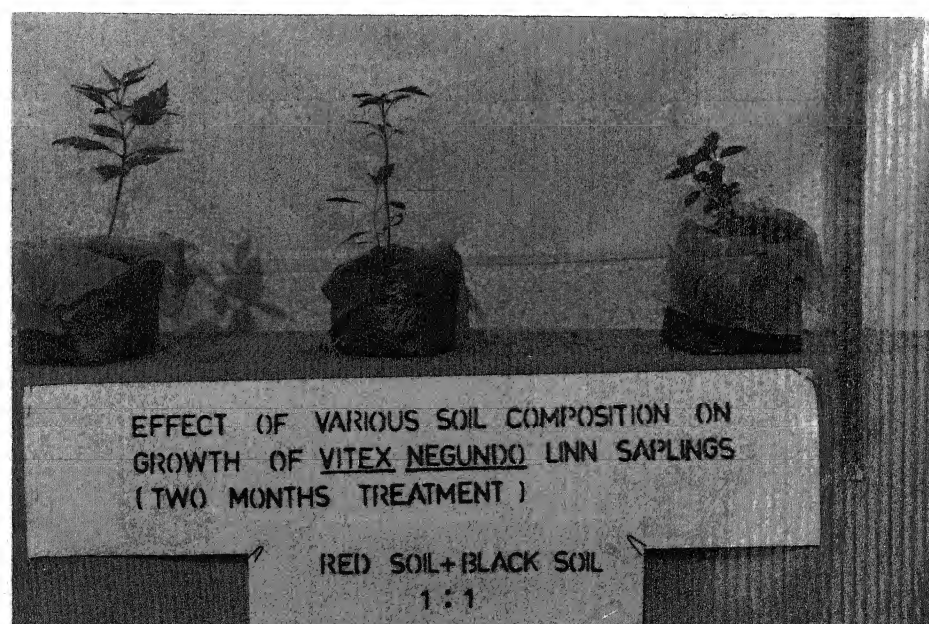


Plate - 8 : RED SOIL + SAND(1:1) : Effect of various soil composition on growth of *Vitex negundo* Linn sapling (Two month treatment).

BLACK SOIL

Plate - 9: RED SOIL + BLACK SOIL (1:1): Effect of various soil composition on growth of *Vitex negundo* Linn sapling (Two month treatment).

also followed the similar trend with maximum girth in pure sand and minimum in Red+Black soil (1:1) (Table 7.2). Table 7.3 & 7.4 indicates number of both lateral roots and leaves which were maximum in pure sand. Leaf area was also maximum in pure sand and minimum in Red+Black soil (1:1) (Table 7.4). It seems that pure sand is relatively more favourable for obtaining maximum growth in *V. negundo*.

Dry Matter Production

Data on dry matter production is given in Table 7.5 fig 7.2. The production of above ground parts (stem and leaves) indicate that maximum dry matter was produced in pure sand and minimum in Red+Black soil (1:1). The difference was significant statistically. Production of below ground parts also exhibited similar trends.

Thus the result seems to suggest the basic availability of nutrients or the water holding capacity was not of much importance for *V. negundo* seedlings, but it was the soil porosity, which favourably influenced the production of dry matter.

Plant Growth

For plant growth analysis RGR, NAR and LAR were calculated and are given in Table 7.6, 7.7 & 7.8 respectively.

Table 7.5 Effect of various combinations of different soil compositions on dry matter production (g) in *Vitex negundo* L. Seedlings*.

Soil composition	Seedlings harvested after								
	2 months			4 months			6 months		
	R	S	L	R	S	L	R	S	L
Pure black	0.06	0.04	0.13	0.26	0.19	0.26	0.57	0.26	0.40
Pure red	0.15	0.13	0.20	0.66	0.23	0.49	0.67	0.52	0.52
Pure sand	0.41	0.29	0.34	1.09	0.57	0.61	1.58	0.74	1.05
Black+Sand (1:1)	0.04	0.10	0.13	0.11	0.27	0.24	1.03	0.41	0.64
Red + Sand (1:1)	0.11	0.07	0.12	0.19	0.13	0.15	0.64	0.35	0.26
Red+Black (1:1)	0.06	0.04	0.07	0.08	0.08	0.09	0.30	0.15	0.14
Red+Black+Sand (1:1:1)	0.17	0.10	0.15	0.43	0.25	0.37	0.78	0.45	0.52
SEm \pm	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.01
C. D. _{0.05}	0.02	0.02	0.02	0.06	0.05	0.03	0.05	0.02	0.03

* Average of 3 plants per treatment

SEm = Standard error of mean

C.D. = Critical difference

Legends : R = Root, S = Stem, L = Leaves

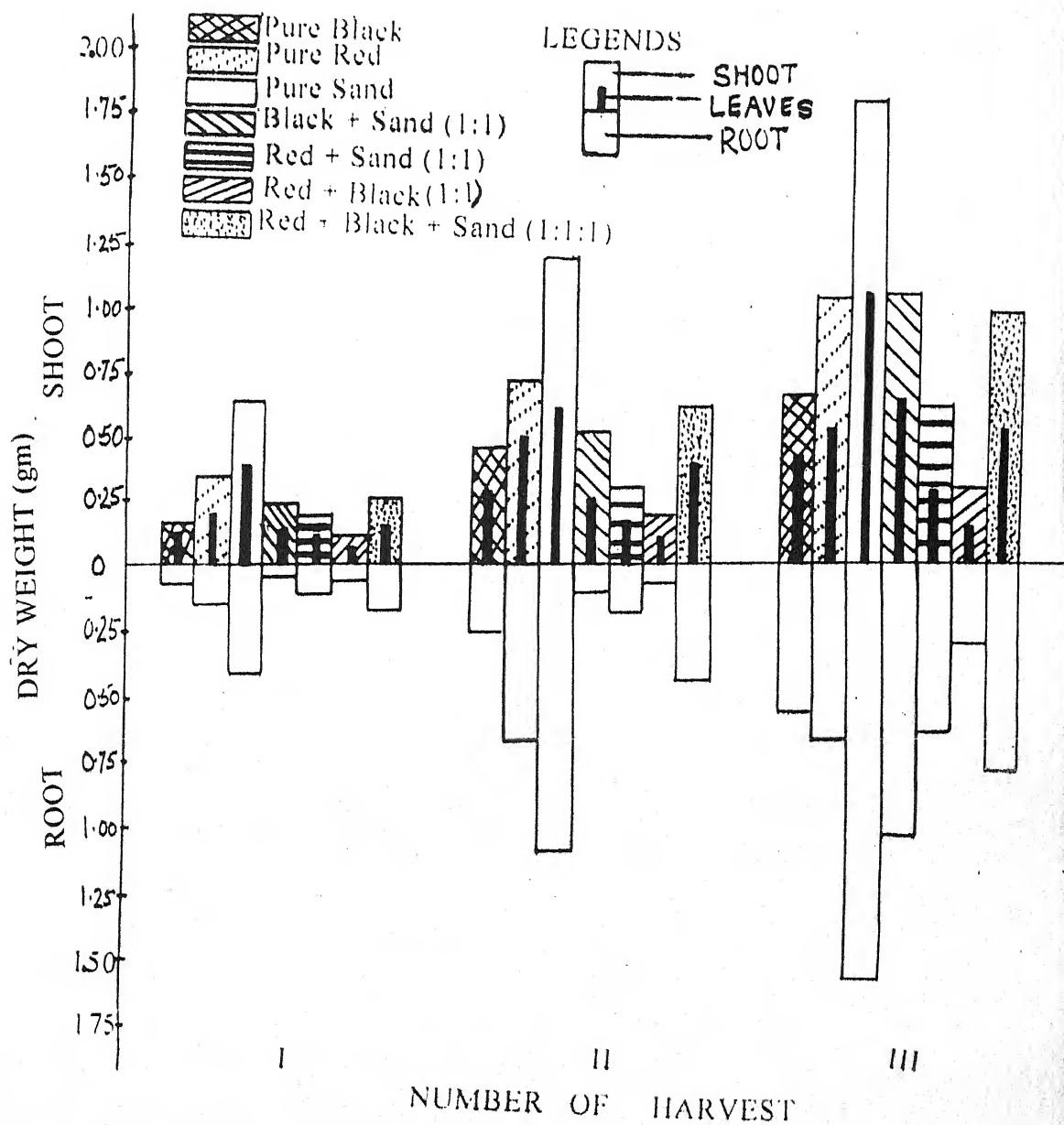
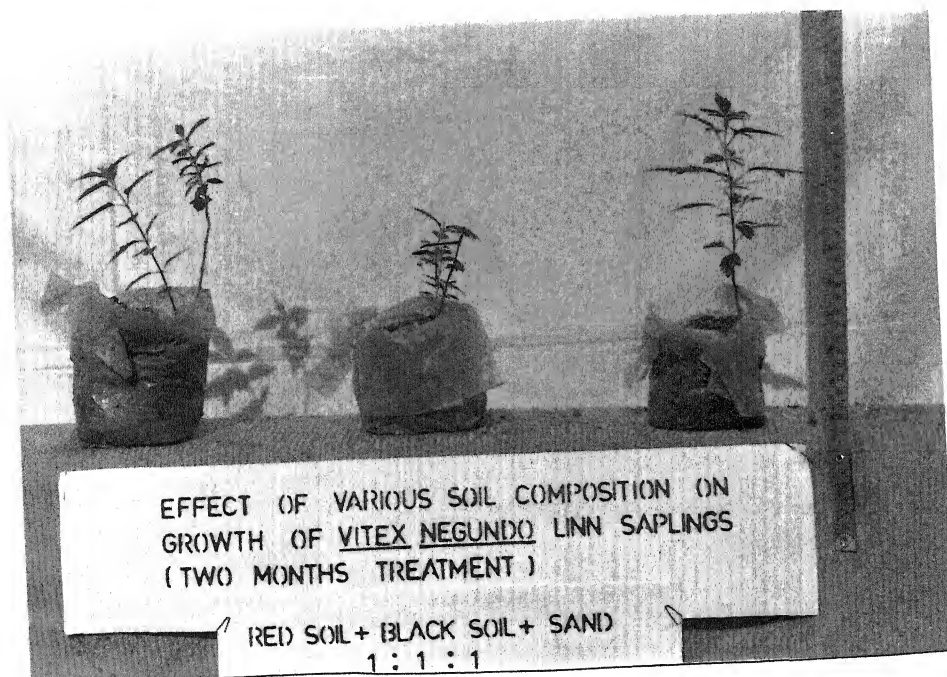


Figure 7.2 Dry weight of *Vitex negundo* seedlings under different soil composition



EFFECT OF VARIOUS SOIL COMPOSITION ON
GROWTH OF VITEX NEGUNDO LINN SAPLINGS
(TWO MONTHS TREATMENT)

RED SOIL + BLACK SOIL + SAND
1 : 1 : 1

Plate -10: RED SOIL+ BLACK SOIL+ SAND (1:1:1) :
Effect of various soil composition on growth of ***Vitex
negundo*** Linn sapling (Two month treatment)

The maximum RGR of 2 months old treatment was obtained in pure sand followed by pure red soil and minimum in Red+Black soil (1:1). In 4 months old treated seedlings RGR was maximum in pure Black soil followed by pure Red and minimum in Red+Black soil (1:1). In 6 months old treated seedlings it was maximum in Black+sand soil (1:1) followed by Red+sand soil (1:1) and minimum in pure Red soil (fig 7.3)

NAR

Fig 7.4 indicate that in 2 months old treated seedlings NAR was maximum in sand followed by Red+Black soil+sand (1:1:1) and minimum in pure Black & Red+Black soil (1:1). In 4 months old treated seedlings NAR was maximum in pure Red soil followed by Red+Black soil+sand (1:1:1) and minimum in Red+sand & Red+Black soil (1:1). In 6 months old treated seedlings NAR also showed the similar trend as of RGR.

LAR

Leaf area ratio is a parameter indicating the amount of dry matter synthesized and present in per unit area of leaf. At each harvesting LAR was maximum in pure Black soil. In 2 months old treated seedlings LAR was minimum in Red+Black soil + sand (1:1:1). In 4 and 6 months old treated seedlings it was minimum in pure sand (fig 7.5)

Table 7.6 RGR (mg/g/month) of *Vitex negundo* L. seedlings under different soil composition .

Soil composition	RGR (mg /g /month)		
	2 months	4 months	6 months
Pure black	230	240	250
Pure red	390	230	50
Pure sand	560	170	80
Black+Sand (1:1)	260	180	260
Red + Sand (1:1)	290	100	210
Red+Black (1:1)	160	80	180
Red+Black+Sand (1:1:1)	360	200	110

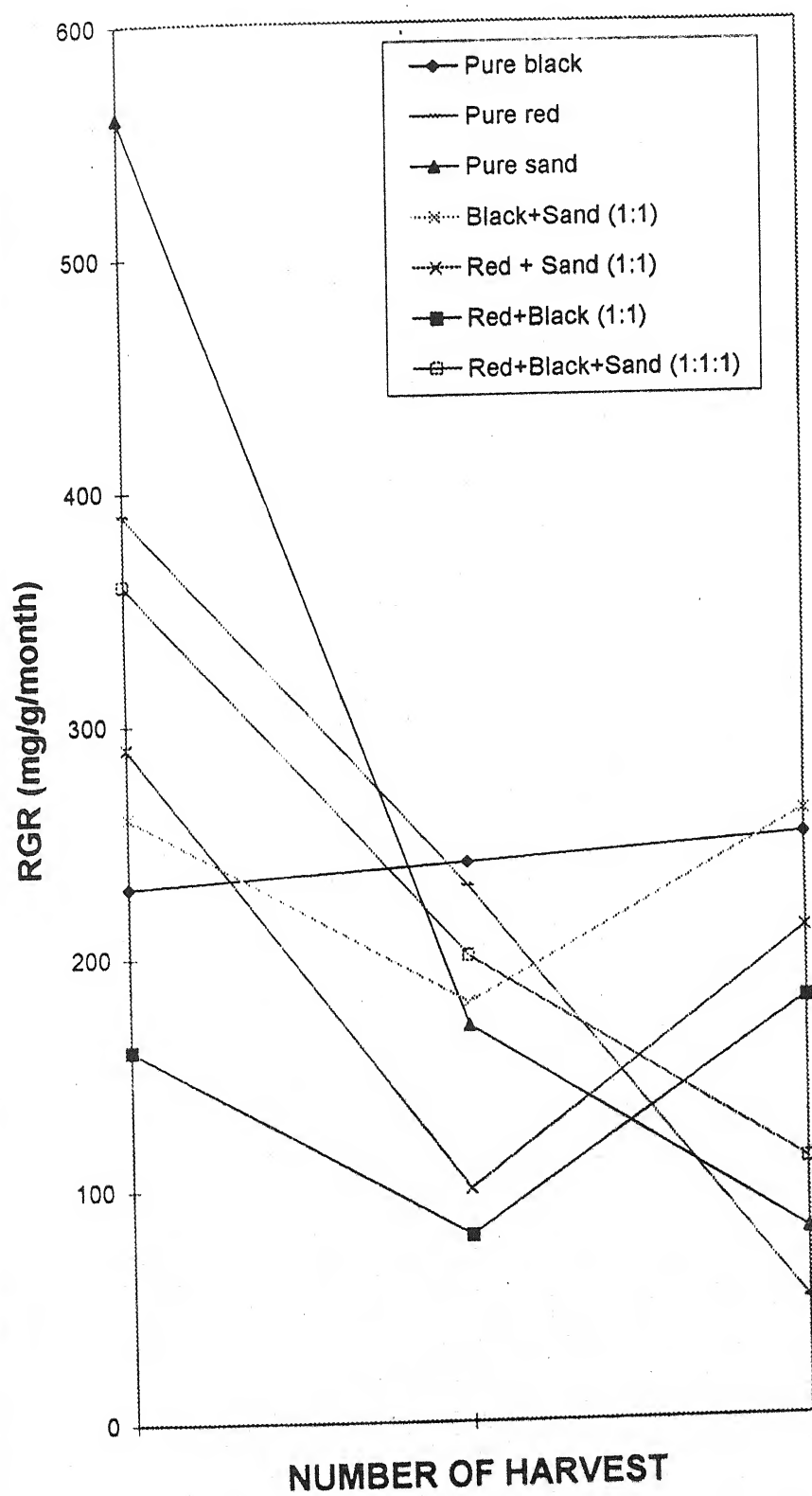


Fig 7.3 RGR of *Vitex negundo* seedlings under different soil composition.

Table 7.7 NAR (mg / cm² /month) of *Vitex negundo* L. seedlings under different soil composition .

Soil composition	NAR (mg /cm ² /month)		
	2months	4months	6 months
Pure black	1.8	2.7	2.2
Pure red	4.0	3.4	0.9
Pure sand	6.6	3.0	1.8
Black+Sand (1:1)	2.3	2.4	5.3
Red + Sand (1:1)	3.5	1.3	4.5
Red+Black (1:1)	1.8	1.3	3.8
Red+Black+Sand (1:1:1)	4.5	3.3	2.2

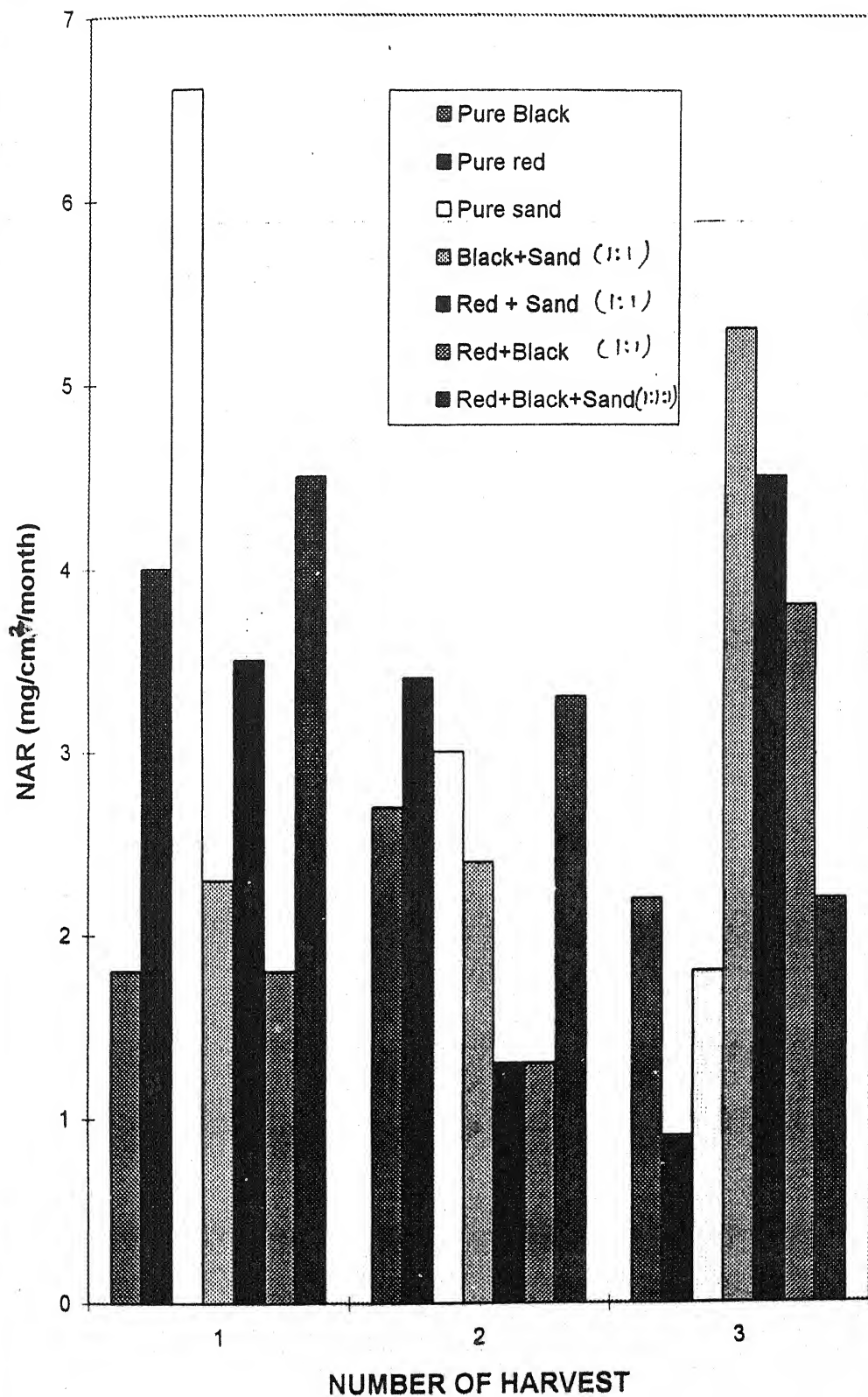


Figure 7.4 NAR of *Vitex negundo* seedlings under different soil composition.

Table 7.8 LAR (cm^2/g) of *Vitex negundo* L. seedlings under different soil composition .

Soil composition	LAR (cm^2/g)		
	2 months	4 months	6 months
Pure black	120.35	89.51	53.21
Pure red	97.27	67.28	48.27
Pure sand	84.22	55.68	46.65
Black+Sand (1:1)	109.88	69.43	49.46
Red + Sand (1:1)	82.78	68.51	46.94
Red+Black (1:1)	82.51	61.70	48.83
Red+Black+Sand (1:1:1)	79.85	59.59	50.29

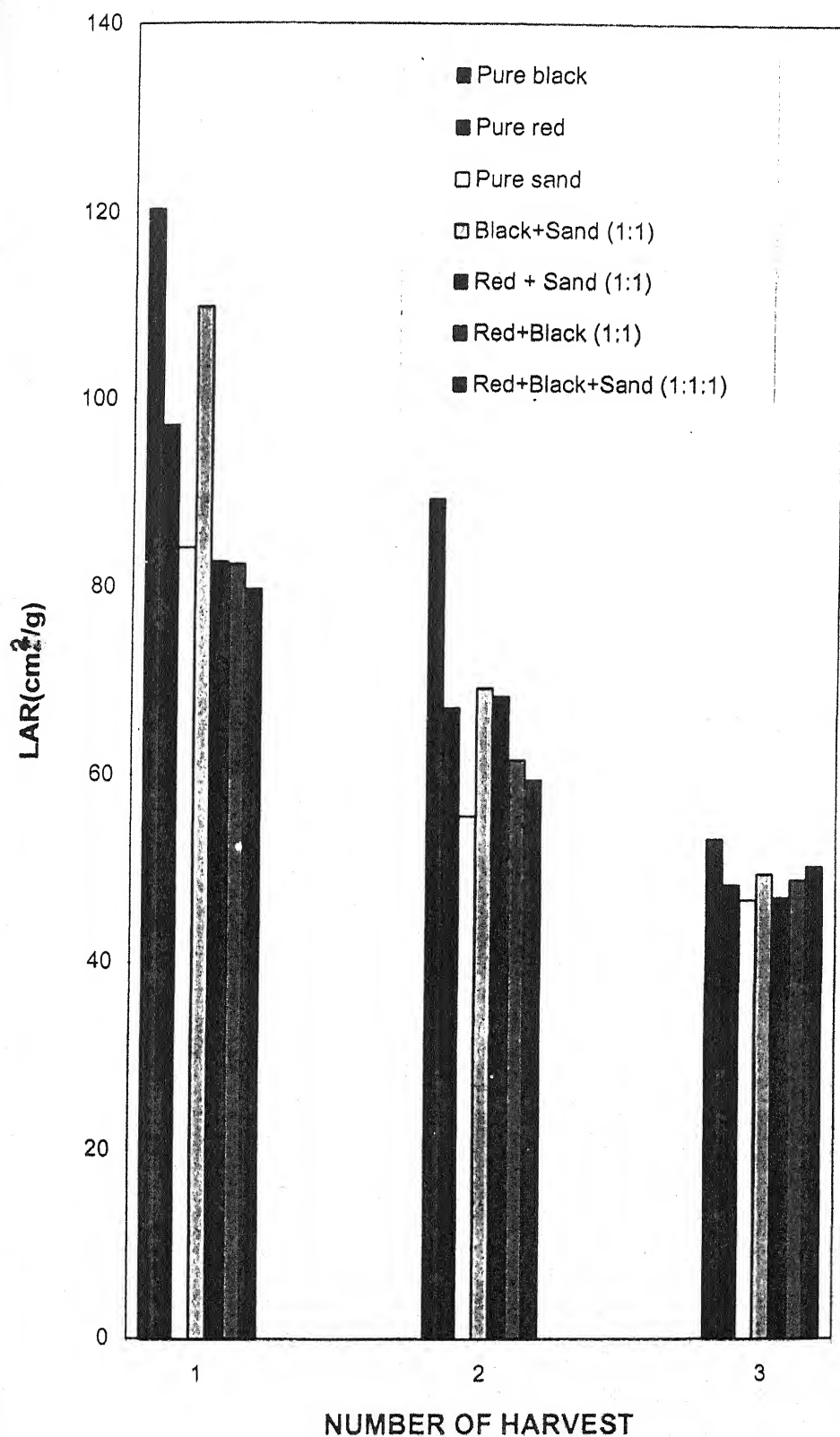


Figure 7.5 LAR of *Vitex negundo* seedlings under different soil composition.

According to **Shankar** (1970) soil texture treatment reveals that sandy soils favour healthy growth of *Trichodesma amplexicaule*.

Similar results were obtained in seedling growth of *Dichrostachys cinerea* a multipurpose leguminous tree by **Roy and Pathak** (1985).

Misra and Joshi (1952) attributed maximum significance to edaphic factor amongst all other environmental factors. **Miller et al**, (1965) observed that the rate and extent of many important physical and chemical reactions are governed by soil texture because it determines the amount of surface on which the reactions occur. Health and vigour of plants are conditioned by the distribution and activities of roots. For proper root growth, soil type and more particularly the soil texture is rather more important than all other soil factors (**Russel**, 1977).

(II) Moisture Regime

Soil moisture is an extremely important aspect of plant environment and that the response to variations in it are diverse. Plant growth is controlled directly by plant water stress and only indirectly by atmospheric and soil water stress. In the physiological process water play many important roles; thus affecting the plant growth. **Hendrickson and veihmeyer** (1931) have studied the influence of dry soil on root extension. plant response to water has been investigated by several workers: (**Benedict et al.**, 1947; **Jones**, 1975 and **Gill et al.**, 1983 etc)

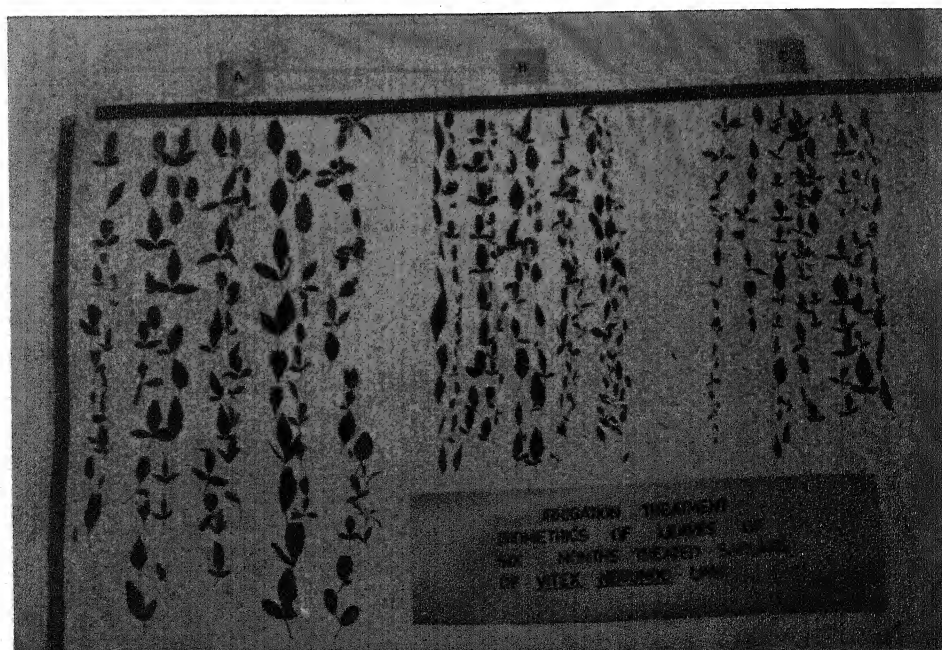
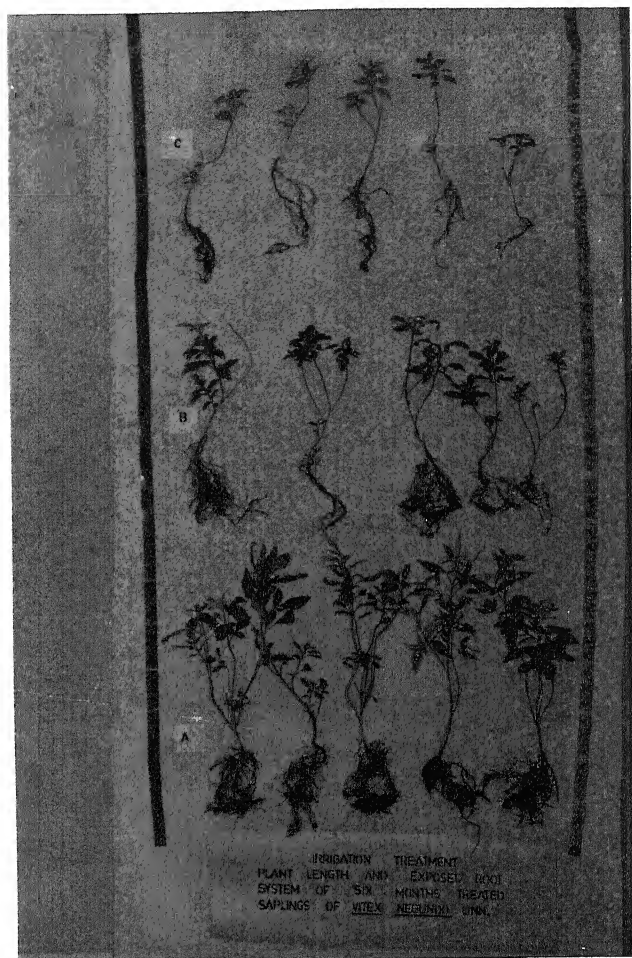


Plate - 11 : IRRIGATION TREATMENT : Plant length and root system of six month treated saplings of *Vitex negundo* Linn.

A=Daily

B=Alternate days

C=Twice in a week

Plate - 12 : IRRIGATION TREATMENT : Biometrics of leaves of six month treated saplings of *Vitex negundo* Linn.

A=Daily

B=Alternate days

C=Twice in a week

Differential irrigation practices have marked effect upon vegetative growth. The root penetration in soil is also greatly influenced by various moisture levels. In the present study Table 7.9 & fig 7.6 indicates that total plant length was maximum in daily watering followed by alternate days, while minimum when watered twice in a week. The other growth parameters, viz; collar circumference, number of lateral roots, number of leaves etc. were also maximum in plants irrigated daily Table 7.10, 7.11, 7.12, As in plant length, the leaf area also followed similar trends with maximum in daily watering medium in alternate days, and minimum in watering twice in a week Table 7.12. Leaf area indicated significant difference. The dry weight of root was maximum at daily irrigation level and steadily decreased towards the lower moisture level. The dry weight of stem and leaves also followed the same pattern of growth.

Dry matter production

The perusal of Table 7.13 & fig 7.7 indicate that the above ground dry matter production variability in relation to moisture status of soil was statistically significant. At higher soil water status it produced maximum dry matter. In second and fourth months harvesting the stem dry weight showed significant difference between all levels of watering but in final harvesting (six months) there was no significant difference between alternate day and twice in a week. Leaves dry weight showed significant difference.

Table 7.9 Effect of irrigation on total length (cm) of *Vitex negundo* L. seedlings *

Irrigation regimes	Seedlings harvested after		
	2 months	4 months	6 months
Daily	33.70	41.70	47.00
Alternate days	31.80	36.40	39.20
Twice in a week	29.70	33.00	36.10
SEm \pm	1.30	1.56	1.69
C.D. 0.05	3.00	3.60	3.91

* Average of 5 plants per treatment

SEm = Standard error of mean

C.D. = Critical difference

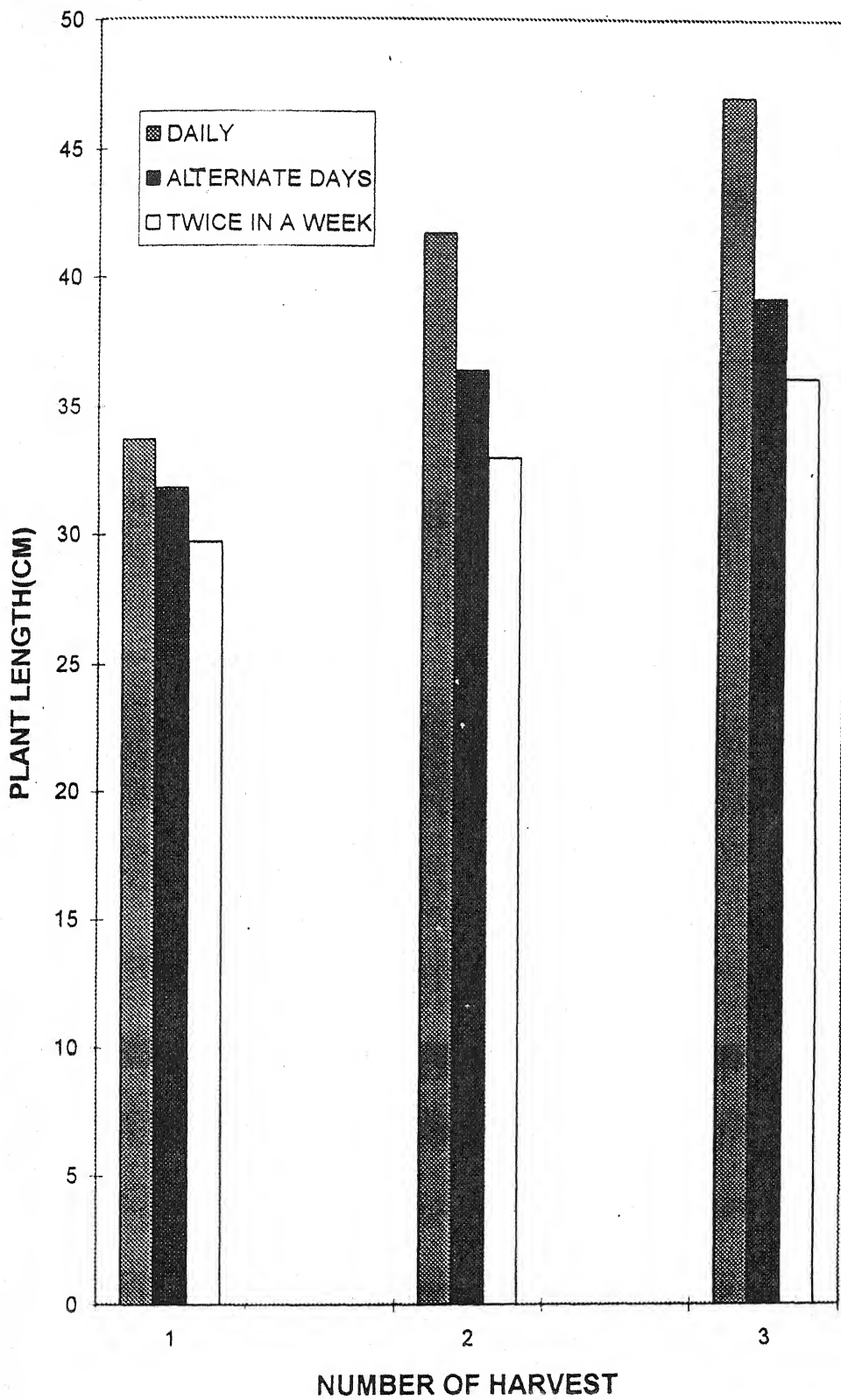


Figure 7.6 Total plant length of *Vitex negundo* seedlings under different irrigation regimes.

Table 7.10 Effect of irrigation on collar circumference (cm) of *Vitex negundo* L. seedlings *.

Irrigation regimes	Seedlings harvested after		
	2 months	4 months	6 months
Daily	0.98	1.08	1.26
Alternate days	0.92	0.98	1.08
Twice in a week	0.88	0.94	1.02
SEm \pm	0.08	0.04	0.06
C.D. _{0.05}	0.19	0.10	0.14

* Average of 5 plants per treatment

SEm = Standard error of mean

C.D. = Critical difference

Table 7.11 Effect of irrigation on number of lateral roots of *Vitex negundo* L. seedlings *.

Irrigation regimes	Seedlings harvested after		
	2 months	4 months	6 months
Daily	11.20	15.80	20.60
Alternate days	9.80	13.00	14.20
Twice in a week	10.20	13.40	19.20
SEm \pm	0.78	0.53	0.64
C.D. _{0.05}	1.80	1.23	1.47

* Average of 5 plants per treatment

SEm = Standard error of mean

C.D. = Critical difference

Table 7.12 Effect of irrigation on number of leaves and leaf area (cm²) of *Vitex negundo* L. seedlings *.

Irrigation regimes	Seedlings harvested after					
	2 months		4 months		6 months	
	Leaves		Leaves		Leaves	
	Number	Area	Number	Area	Number	Area
Daily	15.60	52.67	22.60	60.02	29.40	128.68
Alternate days	13.80	46.93	17.00	52.84	23.60	58.48
Twice in a week	13.20	25.08	14.20	26.59	20.40	36.19
SEm \pm	0.70	0.95	0.84	0.91	0.94	1.56
C.D. _{0.05}	1.61	2.20	1.93	2.09	2.18	3.60

* Average of 5 plants per treatment

SEm = Standard error of mean

C.D. = Critical difference

Table 7.13 Effect of irrigation on dry matter production (g) in *Vitex negundo* L. seedlings *.

Irrigation regimes	Seedlings harvested after								
	2 months			4 months			6 months		
	R	S	L	R	S	L	R	S	L
Daily	0.33	0.26	0.45	0.38	0.38	0.66	0.57	0.75	0.89
Alternate days	0.26	0.21	0.32	0.30	0.24	0.35	0.33	0.33	0.39
Twice in a week	0.25	0.19	0.24	0.30	0.21	0.29	0.31	0.33	0.31
SEm \pm	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.005
C.D. _{0.05}	0.02	0.015	0.014	0.015	0.03	0.02	0.02	0.03	0.01

* Average of 5 plants per treatment

SEm = Standard error of mean

C.D. = Critical difference

Legends :- R=Root S=Stem L=Leaves

Table 7.14 RGR (mg/g/month) of *Vitex negundo* L. seedlings under different irrigation regimes.

Irrigation regimes	RGR (mg / g/ month)		
	2 months	4 months	6 months
Daily	180	70	100
Alternate days	120	20	30
Twice in a week	80	30	40

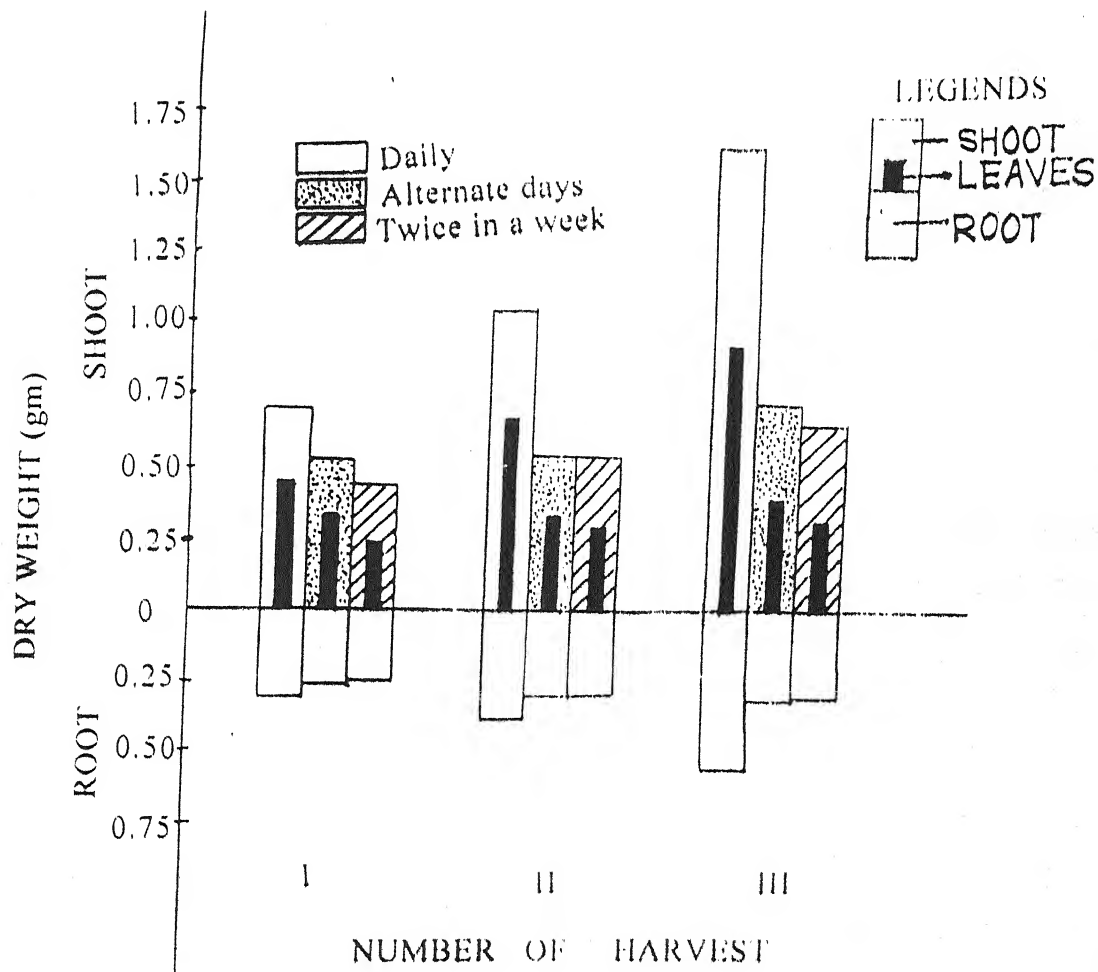


Figure 7.7 Dry weight of *Vitex negundo* seedlings under different irrigation regimes.

The below ground production was also statistically significant whereby the maximum was under daily irrigation and minimum under twice in a week set.

Plant Growth

Data on RGR, NAR and LAR are presented in Table 7.14, 7.15 & 7.16

RGR

Perusal of Table 7.14 & fig 7.8 indicates that the maximum growth was attained in daily irrigation set due to maximum available moisture. Minimum growth was obtained when plants were irrigated twice in a week in seedlings of first harvesting. In second and third harvesting minimum growth was recorded in plants irrigated in alternate days.

NAR

The NAR also showed similar trends as of RGR fig 7.9.

LAR

Maximum leaf area ratio was obtained under alternate day watering condition followed by daily watering in all the harvest. Minimum LAR was observed under twice in a week watering set fig 7.10.

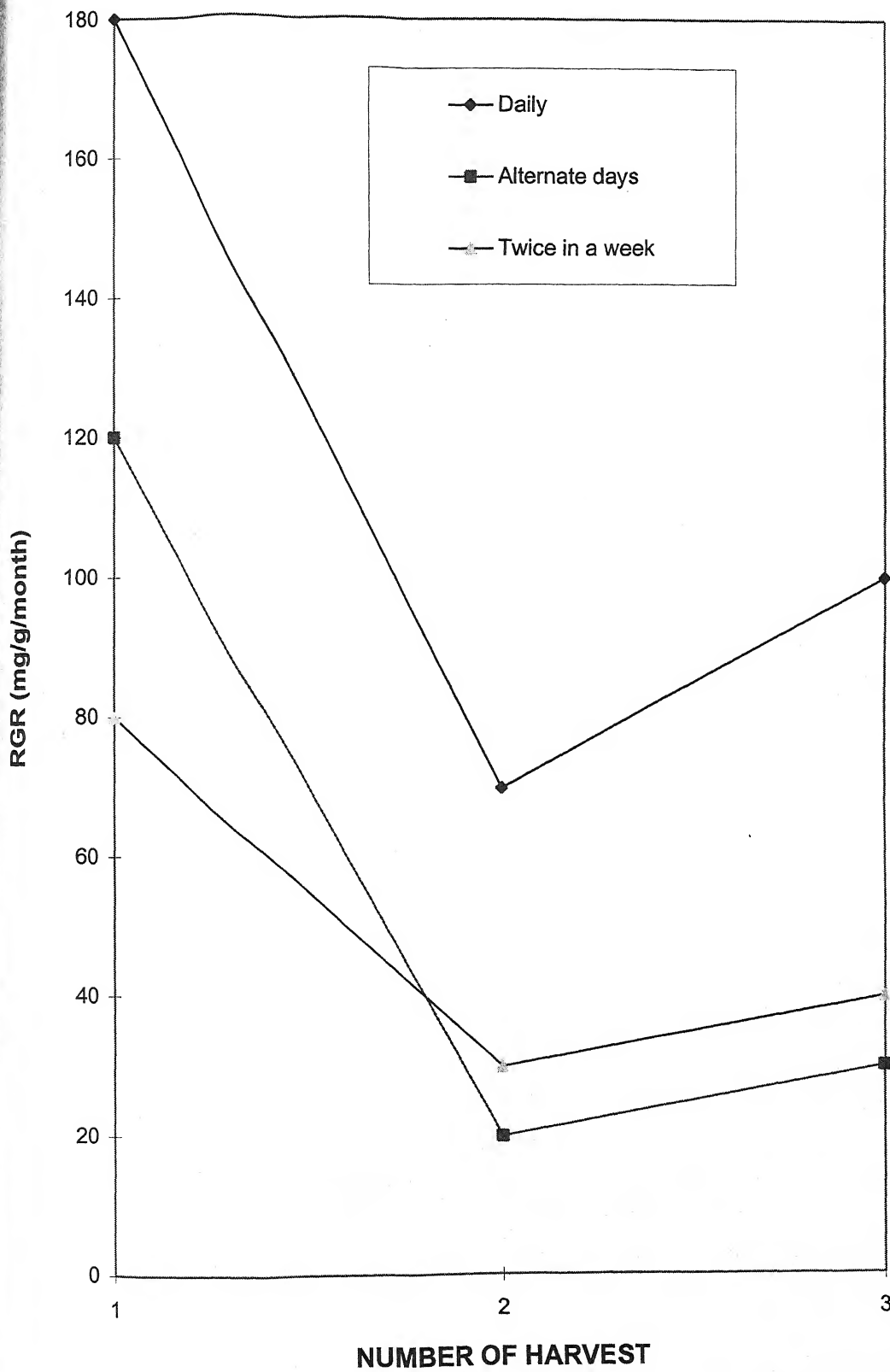


Figure 7.8 RGR of *Vitex negundo* seedlings under different irrigation regimes.

Table 7.15 NAR ($\text{mg /cm}^2/\text{month}$) of *Vitex negundo* L. seedlings under different irrigation regimes.

Irrigation regimes	NAR ($\text{mg /cm}^2/\text{month}$)		
	2 months	4 months	6 months
Daily	3.8	1.5	1.9
Alternate days	2.2	0.4	0.6
Twice in a week	2.2	1.0	1.0

Table 7.16 LAR (cm^2/g) of *Vitex negundo* L. seedlings under different irrigation regimes.

Irrigation regimes	LAR (cm^2/g)		
	2 months	4 months	6 months
Daily	46.30	46.24	50.42
Alternate days	50.47	59.98	57.85
Twice in a week	38.74	35.52	35.64

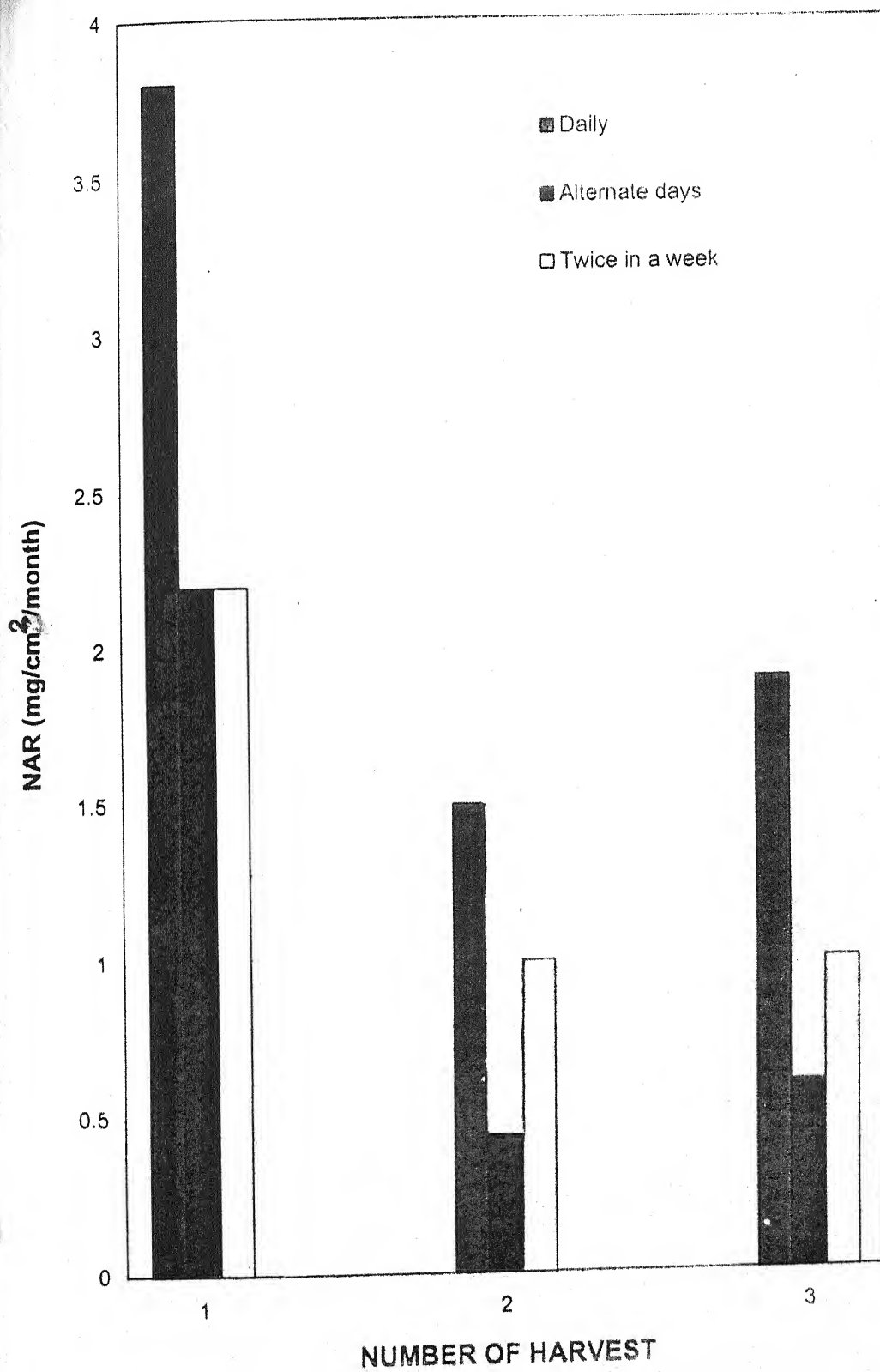


Figure 7.9 NAR of *Vitex negundo* seedlings under different irrigation regimes.

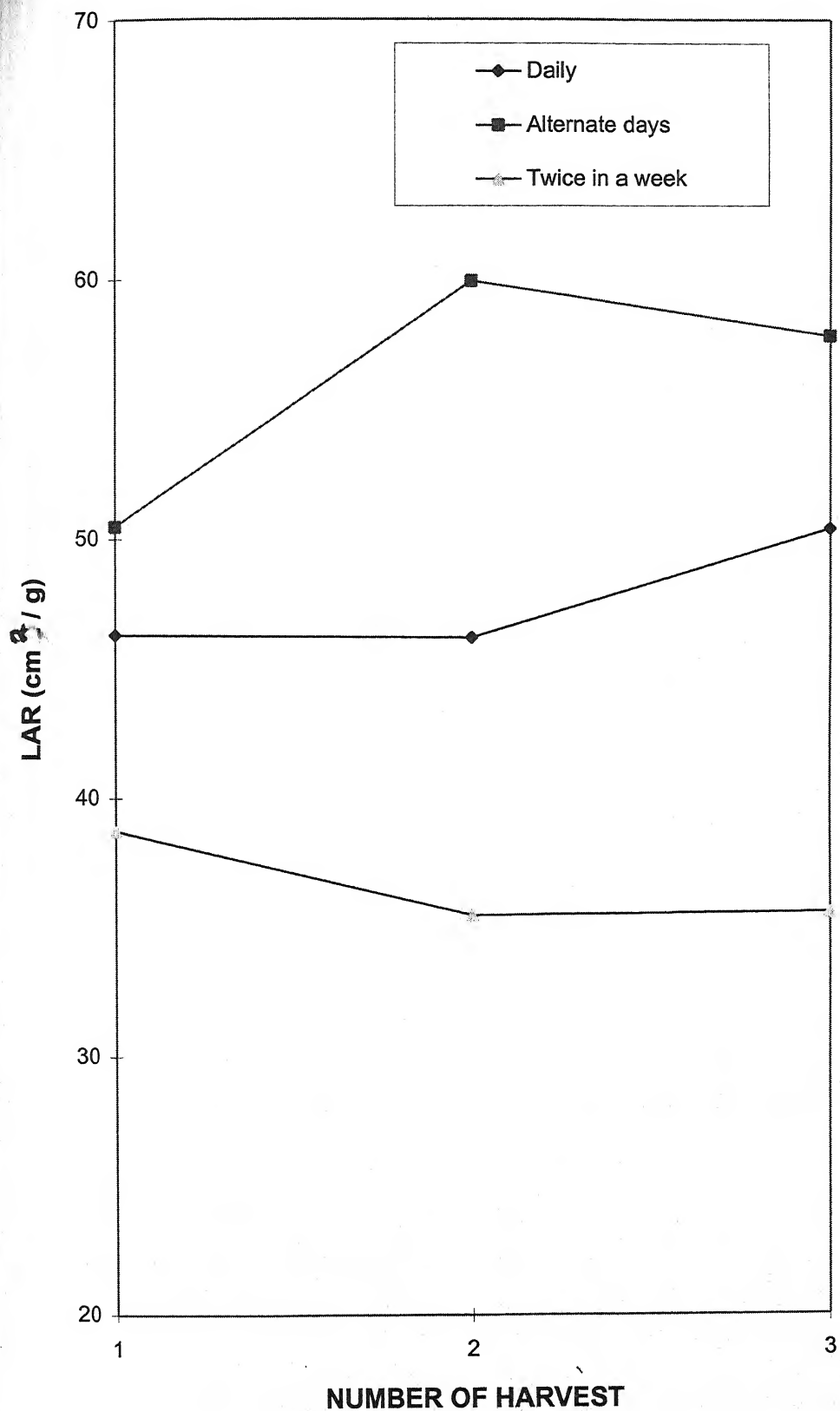


Figure 7.10 LAR of *Vitex negundo* seedlings under different irrigation regimes.

According to **Hudson** (1957) the decreased moisture level raise the soil moisture tension accompanied by rapid and accelerated increase in the osmotic pressure and hence the total moisture stress of the total water uptake by a plant the maximum is lost due to transpiration and small proportion is available for metabolic processes. The water availability effect overall plant performance including maturity, leaf and seed setting.

Brix (1962) observed that decrease in water content invariably reduce the rate of photosynthesis and usually reduces the rate of respiration.

In the present study the growth of ***V.negundo*** seedlings at high moisture level indicates better performance. The root extension maximum at daily watering suggest its adaptability to high moisture level.

Light Conditions

Light is well known for its effect on basic physiological process of plants such as photosynthesis, transpiration, seed germination, flowering and so on . Ecologically both light intensity and its duration are of prime importance for plant growth and it also affect distribution of plants in nature. Light governs the vigour and hight growth of seedling and saplings, seed production composition and character of ground flora besides various other factors.

Plant Growth Performance

The role of light intensity is directly related to the moisture present in soil and the plant growth characteristics as influenced by photosynthesis and transpiration. Table 7.17, 7.18 & 7.20 indicated that total plant length, collar circumference, number of leaves and leaf area were maximum under duffused light. However the maximum number of lateral roots was obtained under full sun light (Table 7.19).

In first harvesting no significant difference in plant length was observed whereas in second and third harvesting is was statistically significant. Two month old treated seedlings exhibited significant differences in their collar circumference but there was no significant differences in 4 and 6 months old treated seedlings . The number of lateral roots were totally non significant. However, during first and third observations the number of leaves was statistically significant.

Maximum dry weight, the above ground as well as below ground plant parts were recorded under diffused light conditions. Both of them were found to be statistically significant.

Dry Matter Production

Data on dry matter productions are presented in Table 7.21 & fig 7.12 Maximum dry weights of leaves (0.86g) and stem (0.76g) were obtained under diffused light conditions and the minimum (leaves 0.43 g and stem 0.46g) were recorded in full sun light . Dry matter

Table 7.17 Effect of light conditions on total length (cm.) of *Vitex negundo* L. seedlings * .

Light conditions	Seedlings harvested after		
	2 months	4 months	6 months
Full sun light	30.00	31.30	34.00
Diffused light	35.00	40.00	45.00
SEm \pm	1.76	0.33	1.00
C.D. _{0.05}	7.59	1.44	4.30

* Average of 3 Plants per treatment

SEm = standard error of mean,

C.D. = critical difference

Table 7.18 Effect of light conditions on collar circumference(Cm) of *Vitex negundo* L. seedlings * .

Light conditions	Seedlings harvested after		
	2 months	4 months	6 months
Full sun light	0.83	1.00	1.13
Diffused light	1.40	1.20	1.33
SEm \pm	0.12	0.06	0.06
C.D. _{0.05}	0.52	0.25	0.25

* Average of 3 Plants per treatment

SEm = standard error of mean,

C.D. = critical difference

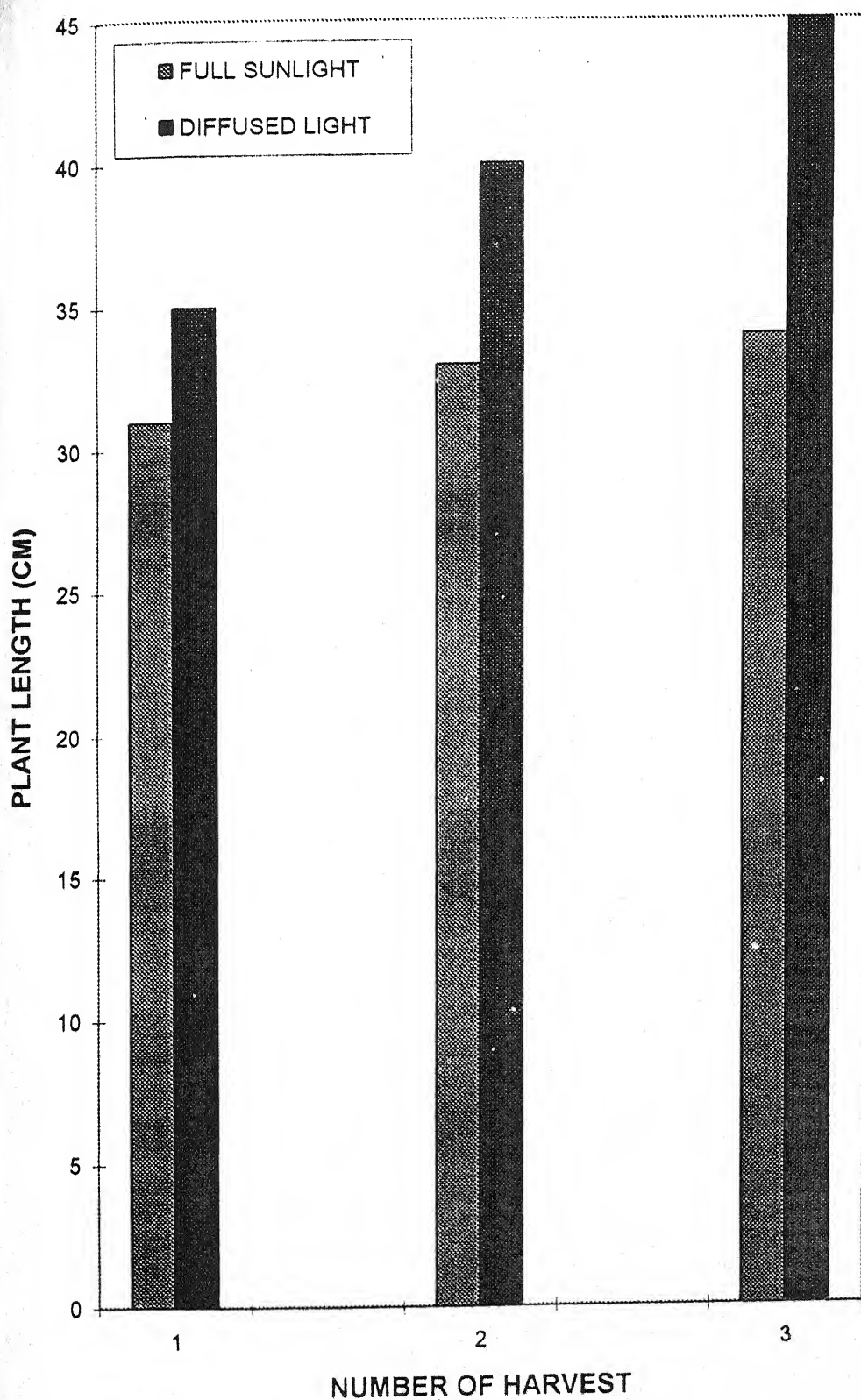
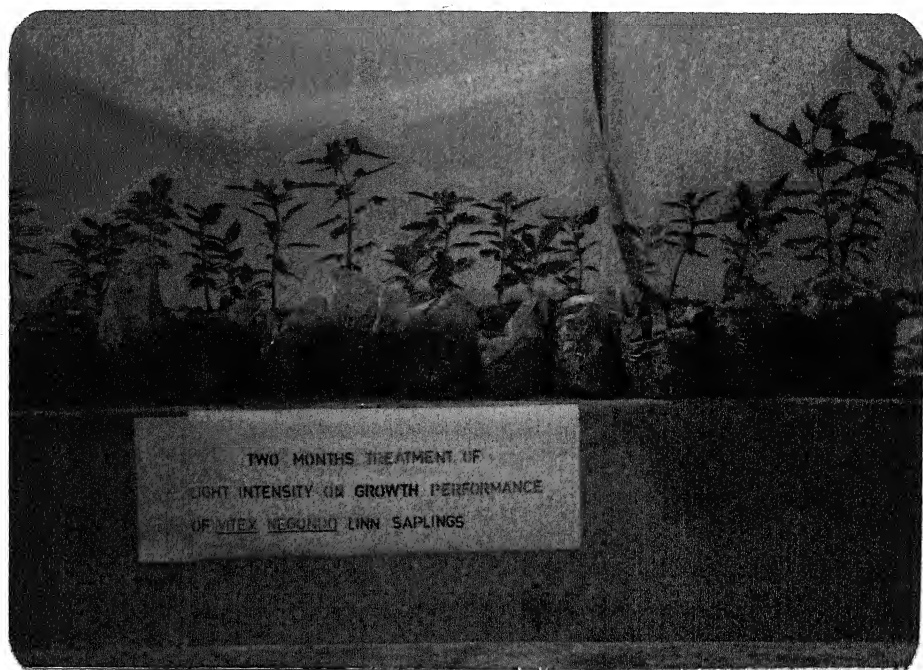
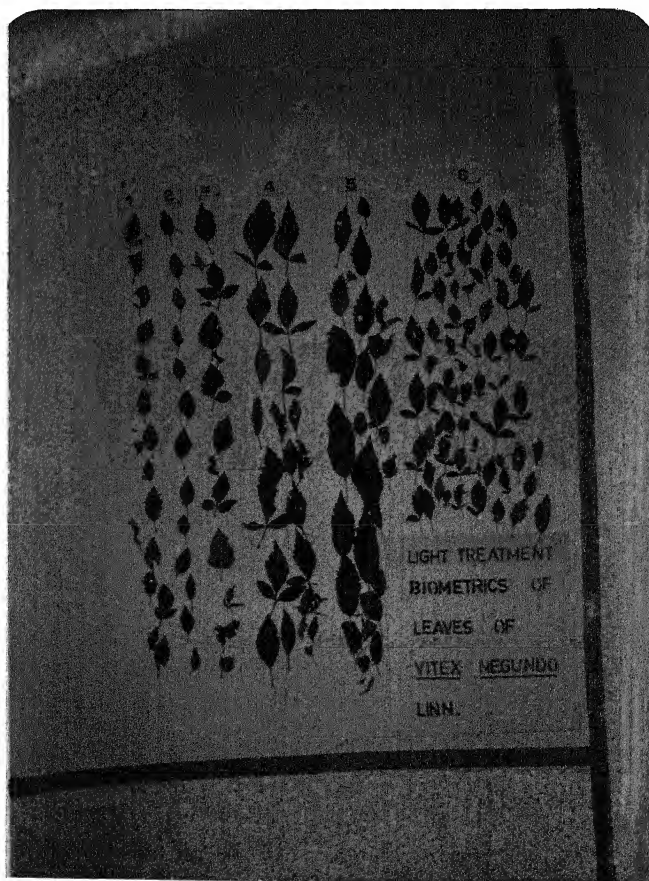


Figure 7.11 Total plant length of *Vitex negundo* seedlings under different light conditions.



TWO MONTHS TREATMENT OF
LIGHT INTENSITY ON GROWTH PERFORMANCE
OF VITEX NEGUNDO LINN SAPLINGS



LIGHT TREATMENT
BIOMETRICS OF
LEAVES OF
VITEX NEGUNDO
LINN.

PLATE -13 : LIGHT TREATMENT : Two month treatment of light intensity on growth performance of *Vitex negundo* Linn saplings.

PLATE - 14 : LIGHT TREATMENT : Biometrics of leaves of two month treated sapling of *Vitex negundo* linn.

full sunlight = 1,2,3

Diffused light =4,5,6

Table 7.19 Effect of light conditions on number of lateral roots of *Vitex negundo* L. seedlings *.

Light conditions	Seedlings harvested after		
	2 months	4 months	6 months
Full sun light	16.30	17.00	24.30
Diffused light	14.00	16.00	23.30
SEm \pm	0.88	2.08	2.08
C.D. 0.05	3.80	8.96	8.96

* Average of 3 Plants per treatment

SEm = standard error of mean,

C.D. = critical difference

Table 7.20 Effect of light condition^s on number of leaves and leaf area (cm²) of *Vitex negundo* seedlings

Light conditions	Seedlings harvested after					
	2 months		4 months		6 months	
	Leaves		Leaves		Leaves	
	Number	Area	Number	Area	Number	Area
Full sun light	15.30	28.68	22.30	57.12	25.30	66.91
Diffused light	21.67	112.94	26.30	157.41	29.67	192.72
SEm \pm	1.20	0.99	2.64	4.36	0.88	1.91
C.D. 0.05	5.17	4.25	11.38	18.76	3.79	8.24

* Average of 3 Plants per treatment

SEm = standard error of mean,

C.D. = critical difference

TABLE- 7.21 Effect of light conditions on dry matter production(g) of *Vitex negundo* L. seedlings*.

Light conditions	Seedlings harvested after								
	2 months			4 months			6 months		
	R	S	L	R	S	L	R	S	L
Full sun light	0.10	0.16	0.37	0.13	0.25	0.40	0.85	0.46	0.43
Diffused light	0.26	0.25	0.50	0.32	0.57	0.84	1.14	0.76	0.86
SEm \pm	0.002	0.02	0.01	0.01	0.01	0.01	0.04	0.01	0.01
C. D. 0.05	0.01	0.09	0.03	0.05	0.06	0.05	0.16	0.03	0.05

*Average of 3 plants per treatment

SEm \pm = Standard error of mean

C. D. = Critical difference

Legends: R = Root S = Stem L = Leaves

Table 7.22 RGR(mg/g/month) of *Vitex negundo* L. seedlings under different light conditions.

Light conditions	RGR(mg/g/month)		
	2 months	4 months	6 months
Full sun light	60	50	170
Diffused light	170	120	100

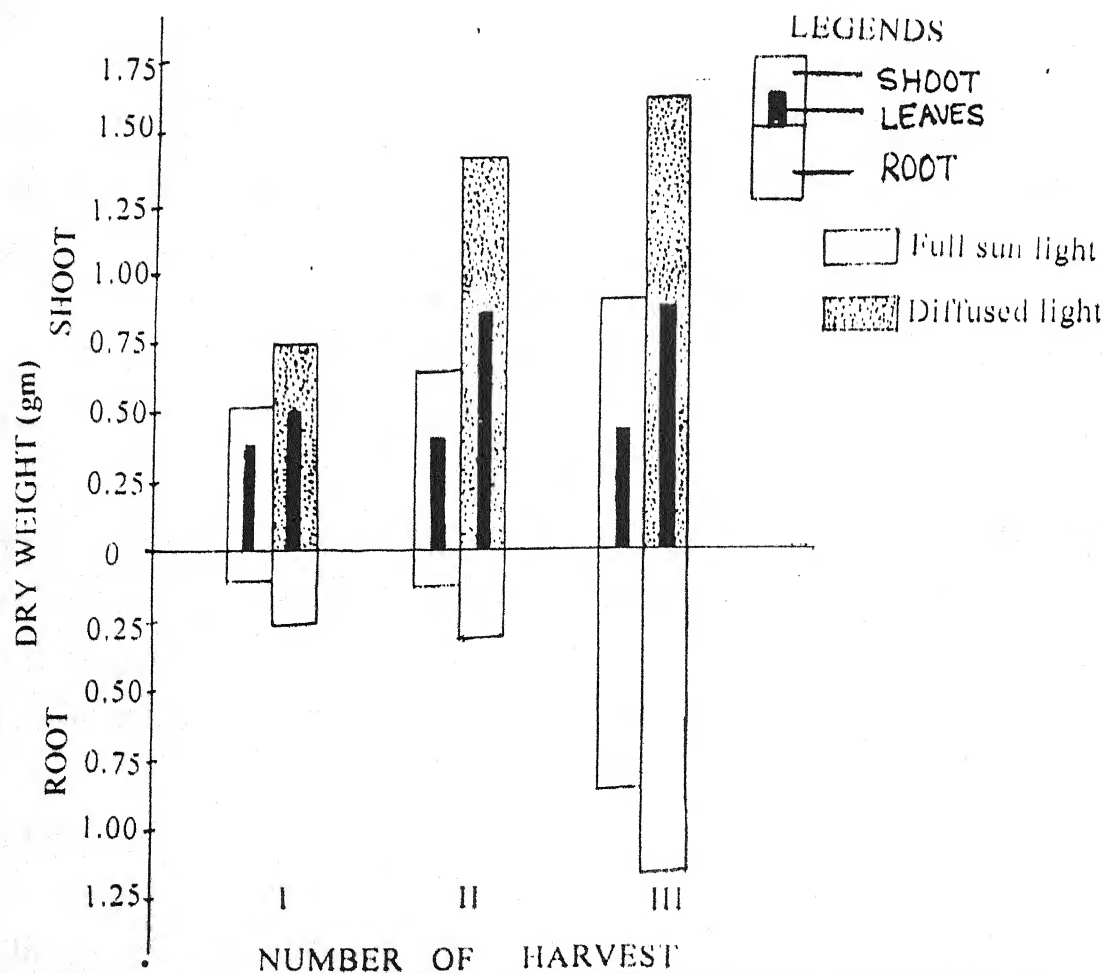


Figure 7.12 Dry weight of *Vitex negundo* seedlings under different light conditions.

production of below ground parts also exhibited the same pattern and was found to be statistically significant.

Plant Growth

Results obtained show that the growth behaviour of plant was markedly affected by different light intensities. The RGR, NAR and LAR are provided in Table 7.22, 7.23 & 7.24 respectively.

RGR

Under diffused light plant growth rate was high with maximum dry matter production in 2 and 4 month old treatment. Results of 6 month old treated seedlings exhibited minimum growth rate in full sun light with poor biomass production (fig 7.13).

NAR

The trend of NAR in various light intensities was exactly similar like that of RGR(fig 7.14).

LAR

Fig 7.15 indicates that maximum LAR was obtained in diffused light condition. This suggest that the light intensity play significant role in controlling the size and number of leaves in order to produce optimum photosynthetic area for carbohydrate production.

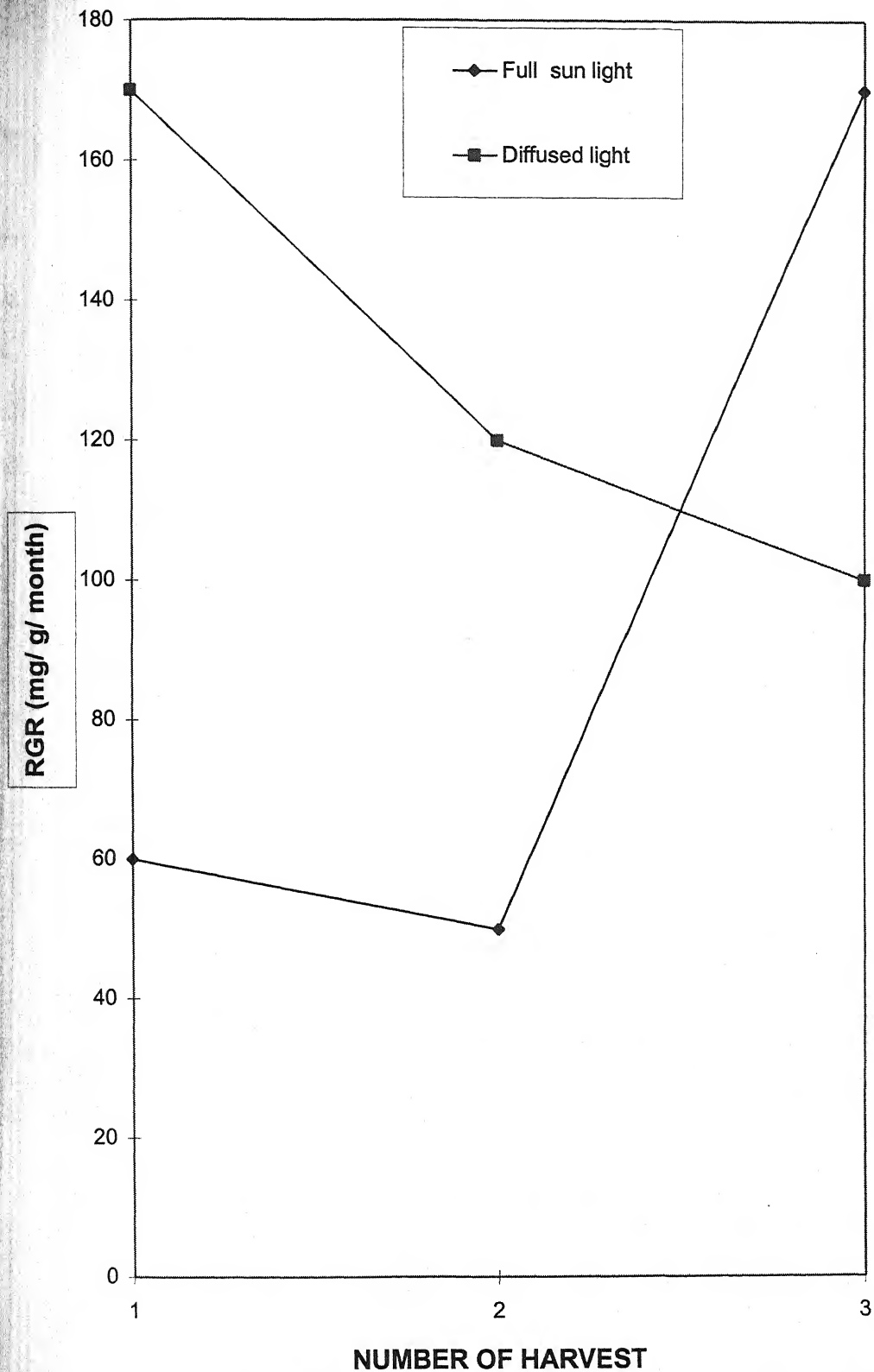


Figure 7.13 RGR of *Vitex negundo* seedlings under different light conditions.

Table 7.23 NAR(mg/cm²/month) of *Vitex negundo* L. seedlings under different light conditions.

Light conditions	NAR(mg/cm ² /month)		
	2 months	4 months	6 months
Full sun light	1.5	0.7	3.4
Diffused light	2.2	1.1	1.3

Table 7.24 LAR (cm²/g) of *Vitex negundo* L. seedlings under different light conditions

Light conditions	LAR (cm ² /g)		
	2 months	4 months	6 months
Full sun light	42.82	58.75	55.92
Diffused light	74.41	100.13	79.16

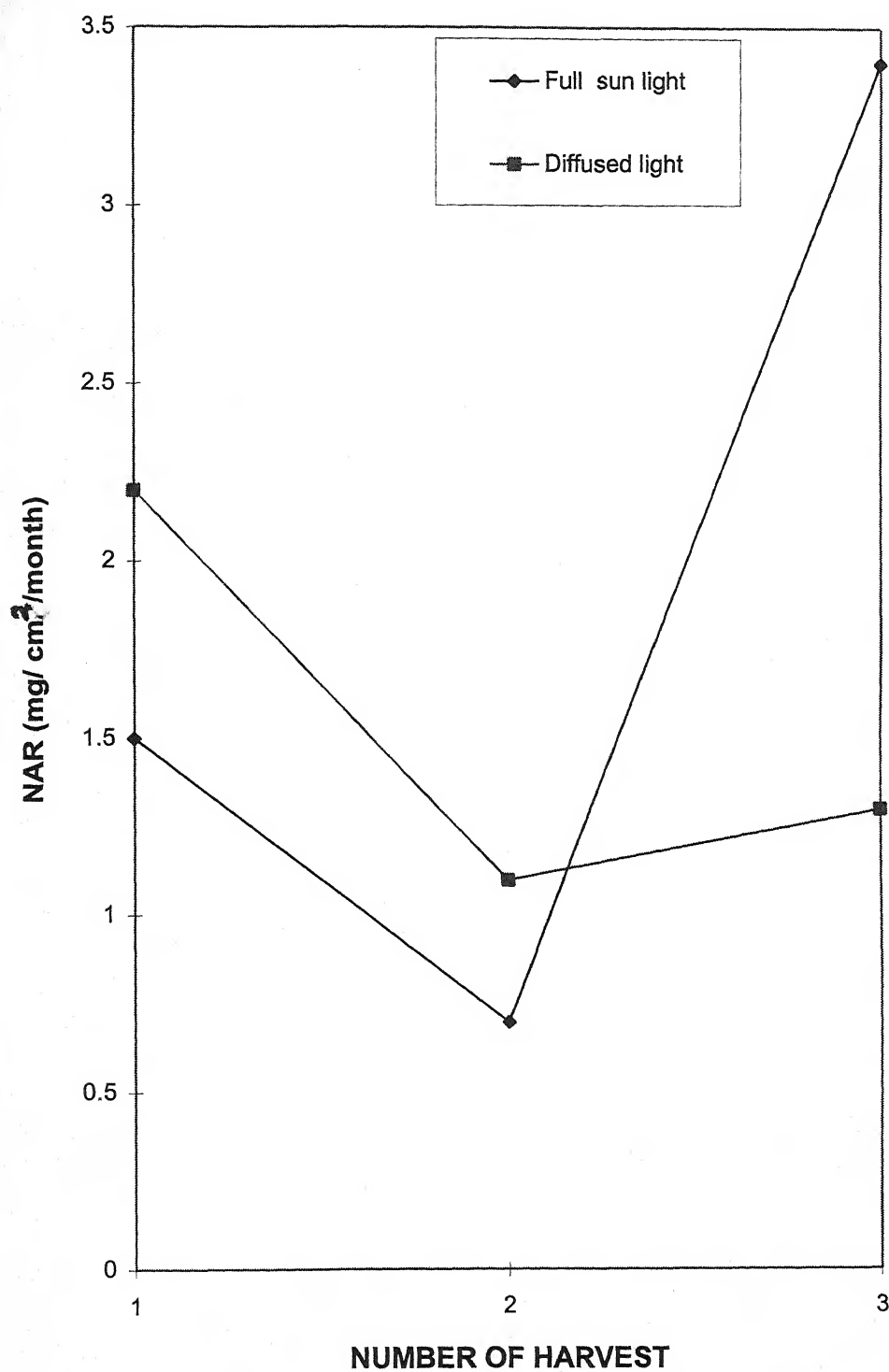


Figure 7.14 NAR of *Vitex negundo* seedlings under different light conditions.

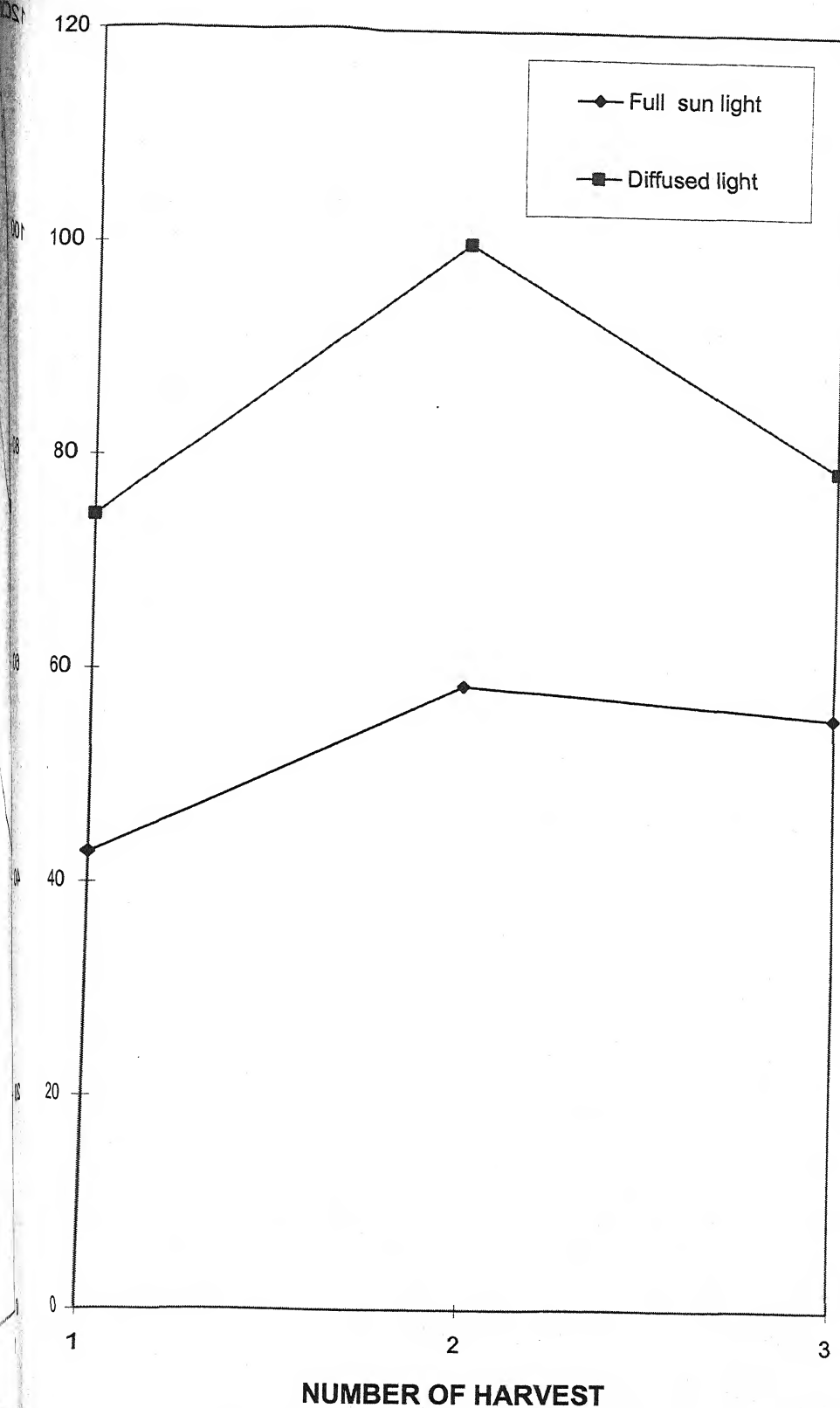


Fig 7.15 LAR of *Vitex negundo* seedlings under different light conditions.

Shading influence growth behaviour of plants. Reduction in light intensity is said to be responsible for the erect habit. Even in moderate shading the reduction in dry matter production has been observed in many grass spp. (**Singh and Misra, 1969**). **Lockhart (1963)** opined that shading act by increasing effective level of gibberellic acid at the growing regions of a plant. **Pathak (1969)** has suggested that increasing light intensity usually decrease the LAR. Similar observations were recorded in the present study with ***V. negundo***. Due to shading the above and below ground production was improved as compared to the production in full sun light.

In nursery during summer, at 45% light intensity, **Pathak et al (1983)** observed better growth and dry matter production ***Leucaena leucocephala***. They attributed the higher growth rate at reduced light intensity to the decrease in ambient temperature, light intensity and dessication.

Azad et al (1991) reported that ***Areca catechu*** trees show significantly greater vegetative growth when planted in complete shade than in full sun light or in partial shade.

Sen Gupta and Payne, (1947) have reported that changes in light conditions bring about marked changes in growth behaviour of leaves particularly their shape, size and number in ***Sesamum orientale***.

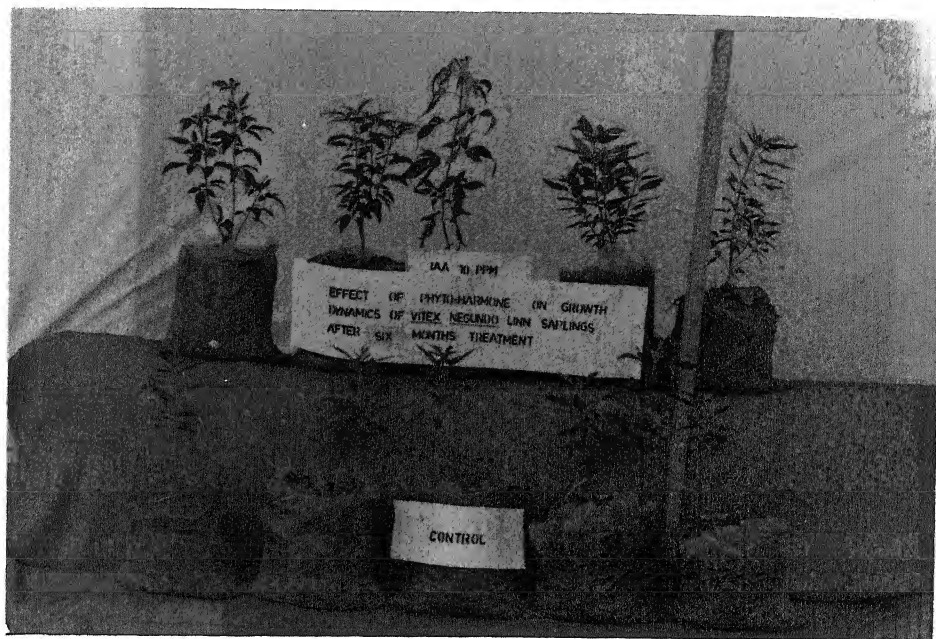


PLATE 15 - : IAA 10ppm : Effect of phytohormone on growth performance of ***Vitex negundo*** Linn sapling after six month treatment.

PLATE 16 - : IAA 100ppm : Effect of phytohormone on growth performance of ***Vitex negundo*** Linn sapling after six month treatment.

Bhatnagar and Gupta (1976) reported that long day treatment (18 hours) was significantly advantageous over other treatments for the dry matter production in *Pines*.

(V) Phytohormones

In recent years, plant hormones have attracted much attention for their expressive roles in growth and development of plants, They play major part in controlling different phases of life including shoot, root growth and dormancy.

Effect of hormones on plants have been studied by various workers **Mehrotra and Dadwal**, (1978) studied the effect of GA_3 on growth of Teak. Two cultivars each of *Luffa Cylindrica* M.U.Roem and *Luffa acutangula* Roxb. exhibited marked influence under IAA, NAA, Abscissic acid Thiourea and 2,4,D treatments in triggering the germination of their seeds (**Sinha and Trivedi**, 1987).

Kumar et al (1991) observed that IAA, IBA and NAA increased germination percentage in *Cassia fistula* and *Bauhinia purpurea* seeds. **Miyajima** (1992) investigated that treatment with GA_3 promote germination in many weed spp. **Nayyar and Bansal** (1992) reported that pretreatment with KNO_3 and IAA proved to be most effective in enhancing germination percentage of onion seeds.

Plant Growth Performance

Role of hormones is to induce all such activities which influence

growth of plant. Phytohormones showed remarkable effect on *V. negundo* seedlings.

Observation presented in Table 7.25 & fig 7.16 indicate that the most effective concentration of phytohormones was GA_3 100 ppm. It increased maximum length of seedlings. However, minimum length of seedlings was observed in MH 10 ppm treatment. The collar circumference, number of leaves, leaf area and total dry weight were maximum in IAA 10 ppm + GA_3 10 ppm concentrations and minimum in MH 10 ppm (Table 7.26, 7.28 & 7.29) Number of lateral roots was higher in IAA 10 ppm + GA_3 100 ppm concentration and lower in MH 100 ppm (Table 7.27).

Maximum root dry weight was observed in IAA 100 ppm and minimum in MH 100 ppm. The stem dry weight was highest in GA_3 10 ppm and lowest in MH 100 ppm (fig. 7.17).

Dry Matter Production

Results of stem and leaves dry weight were found to be statistically significant whereby maximum dry weight of stem and leaves were observed under GA_3 10 ppm and IAA 10 ppm + GA_3 10 ppm treatments, minimum in MH 100 ppm and MH 10 ppm respectively.

Root dry weight was also found statistically significant with maximum under IAA 100 ppm and minimum under MH 100 ppm.

Table 7.25 Effect of some phytohormones on total length (cm) of *Vitex negundo* L. seedlings *

Hormone Concentrations	Seedlings harvested after	
	3 months	6 months
IAA (10ppm)	38.00	66.80
IAA (100ppm)	35.40	78.00
GA ₃ (10ppm)	41.20	70.60
GA ₃ (100ppm)	50.40	83.20
IAA+GA ₃ (10ppm+10ppm)	38.60	61.00
IAA+GA ₃ (10ppm+100ppm)	33.20	69.20
IAA+GA ₃ (100ppm+10ppm)	40.00	65.20
IAA+GA ₃ (100ppm+100ppm)	45.20	75.40
COU (10ppm)	29.40	58.40
COU (100ppm)	36.60	55.80
MH (10ppm)	26.80	54.20
MH (100ppm)	27.00	61.60
Control	35.00	60.80
SEm \pm	0.54	1.21
C. D. _{0.05}	1.05	2.37

*Average of 5 plants per treatment

SEm = Standard Error of Mean

IAA = Indole Acetic Acid

COU = Coumarin

ppm = Parts Per Million

C.D. = Critical Difference

GA₃ = Gibberellic Acid

MH = Maleic Hydrazide

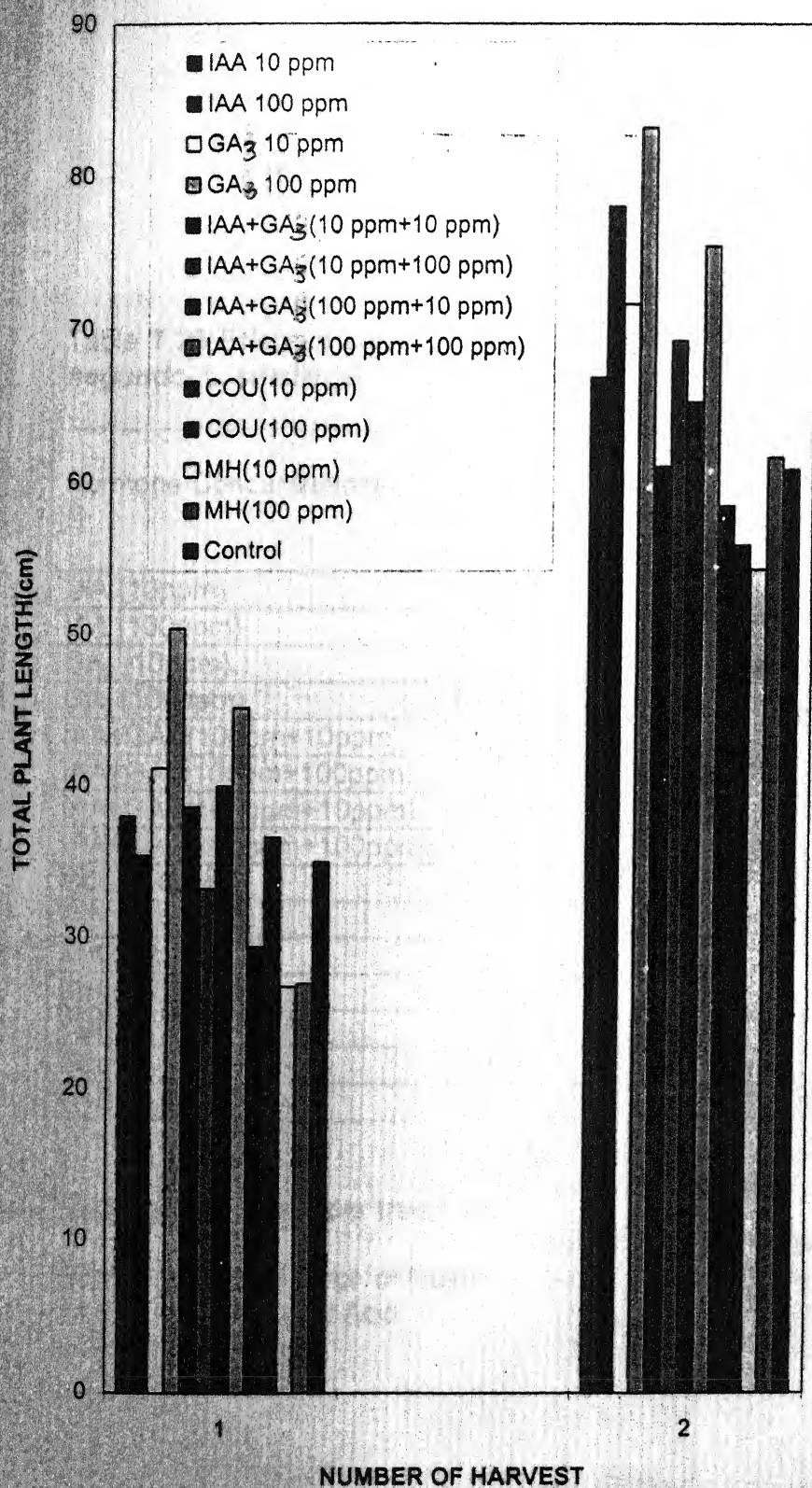


Figure 16 Total plant length of *Vitex negundo* seedlings under some phytohormone treatments.

Table 7.26 Effect of some phytohormones on collar circumference(cm) of *Vitex negundo* L. seedlings :*.

Hormone Concentrations	Seedlings harvested after	
	3 months	6 months
IAA (10ppm)	1.00	1.46
IAA (100ppm)	0.90	2.30
GA ₃ (10ppm)	1.10	1.86
GA ₃ (100ppm)	1.10	1.96
IAA+GA ₃ (10ppm+10ppm)	1.10	2.36
IAA+GA ₃ (10ppm+100ppm)	1.10	1.94
IAA+GA ₃ (100ppm+10ppm)	0.90	1.96
IAA+GA ₃ (100ppm+100ppm)	0.84	1.96
COU (10ppm)	0.78	1.80
COU (100ppm)	0.98	1.44
MH (10ppm)	0.64	1.32
MH (100ppm)	0.70	1.70
Control	0.66	1.40
SEm \pm	0.05	0.07
C. D. _{0.05}	0.10	0.14

*Average of 5 plants per treatment

SEm = Standard Error of Mean

IAA = Indole Acetic Acid

COU = Coumarin

ppm = Parts Per Million

C.D. = Critical Difference

GA₃ = Gibberellic Acid

MH = Maleic Hydrazide

PLATE - 17 : GA₃ 10 ppm : Effect of phytohormone on growth performance of *Vitex negundo* Linn sapling after six month treatment.

PLATE - 18 : GA₃ 100ppm :Effect of phytohormone on growth performance of *Vitex negundo* Linn sapling after six month treatment.

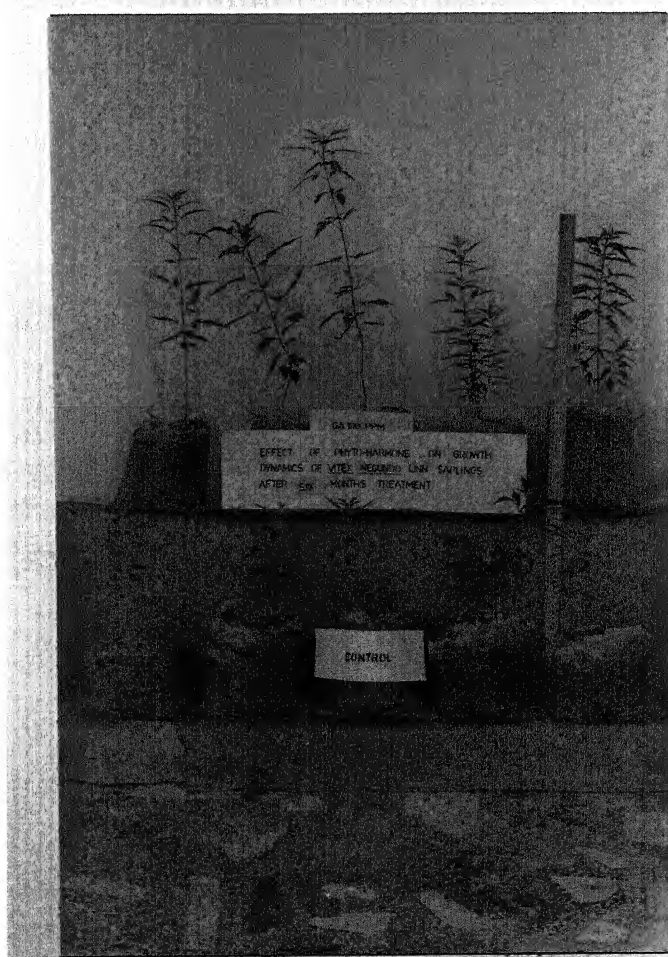


Table 7.27 Effect of some phytohormones on number of lateral roots of *Vitex negundo* L. seedlings *

Hormone Concentrations	Seedlings harvested after	
	3 months	6 months
IAA (10ppm)	11.20	20.80
IAA (100ppm)	11.80	25.40
GA ₃ (10ppm)	11.20	17.40
GA ₃ (100ppm)	13.20	16.40
IAA+GA ₃ (10ppm+10ppm)	10.00	21.00
IAA+GA ₃ (10ppm+100ppm)	13.60	28.80
IAA+GA ₃ (100ppm+10ppm)	12.00	19.00
IAA+GA ₃ (100ppm+100ppm)	10.20	21.60
COU (10ppm)	11.60	14.40
COU (100ppm)	7.00	23.20
MH (10ppm)	6.00	24.00
MH (100ppm)	5.20	12.80
Control	10.40	13.20
SEm ±	0.55	0.77
C. D. _{0.05}	1.07	1.50

*Average of 5 plants per treatment

SEm = Standard Error of Mean

IAA = Indole Acetic Acid

COU = Coumarin

ppm = Parts Per Million

C.D. = Critical Difference

GA₃ = Gibberellic Acid

MH = Maleic Hydrazide

PLATE - 21 IAA 100ppm+GA₃ 10ppm : Effect of phytohormone on growth performance of *Vitex negundo* Linn sapling after six month treatment.

PLATE - 22 IAA 100ppm + GA₃ 100ppm Effect of phytohormone on growth performance of *Vitex negundo* Linn sapling after six month treatment.

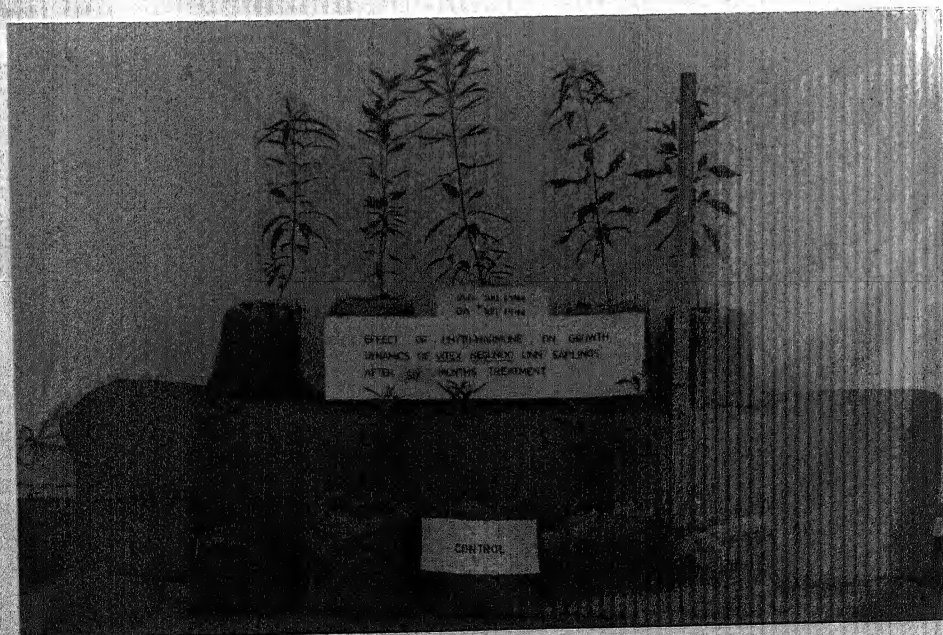


Table 7.29 Effect of some phytohormones on dry matter production^(g) in *Vitex negundo* L. seedlings *

Hormone Concentration	Seedlings harvested after					
	3 months			6 months		
	R	S	L	R	S	L
IAA (10ppm)	0.44	0.27	0.45	2.77	2.03	3.01
IAA (100ppm)	0.48	0.15	0.33	4.33	3.05	6.15
GA ₃ (10ppm)	0.47	0.37	0.40	3.20	3.78	3.56
GA ₃ (100ppm)	0.34	0.31	0.28	4.07	3.13	2.41
IAA+GA ₃ (10ppm+10ppm)	0.36	0.31	0.53	4.06	2.39	6.27
IAA+GA ₃ (10ppm+100ppm)	0.44	0.27	0.46	3.84	3.55	5.14
IAA+GA ₃ (100ppm+10ppm)	0.27	0.17	0.27	3.37	3.07	4.91
IAA+GA ₃ (100ppm+100ppm)	0.22	0.14	0.17	3.17	2.81	2.92
COU (10ppm)	0.13	0.12	0.21	1.71	1.24	3.01
COU (100ppm)	0.23	0.26	0.59	2.39	1.78	3.38
MH (10ppm)	0.07	0.07	0.13	1.73	1.41	0.97
MH (100ppm)	0.06	0.09	0.17	1.30	1.08	1.98
Control	0.19	0.09	0.18	1.74	0.99	1.97
SEm ±	0.01	0.01	0.01	0.03	0.03	0.04
C. D. 0.05	0.02	0.013	0.012	0.06	0.06	0.07

*Average of 5 plants per treatment

SEm = Standard Error of Mean

IAA = Indole Acetic Acid

COU = Coumarin

ppm = Parts per million

C.D. = Critical Difference

GA₃ = Gibberellic Acid

MH = Maleic Hydrazide

Legends :- R = Root

S = Stem

L = Leaves

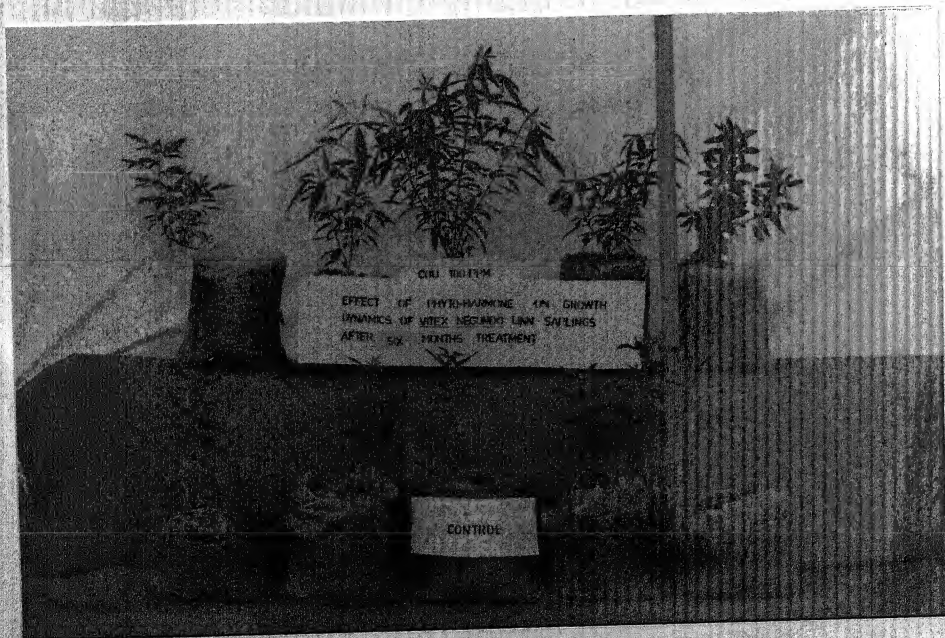
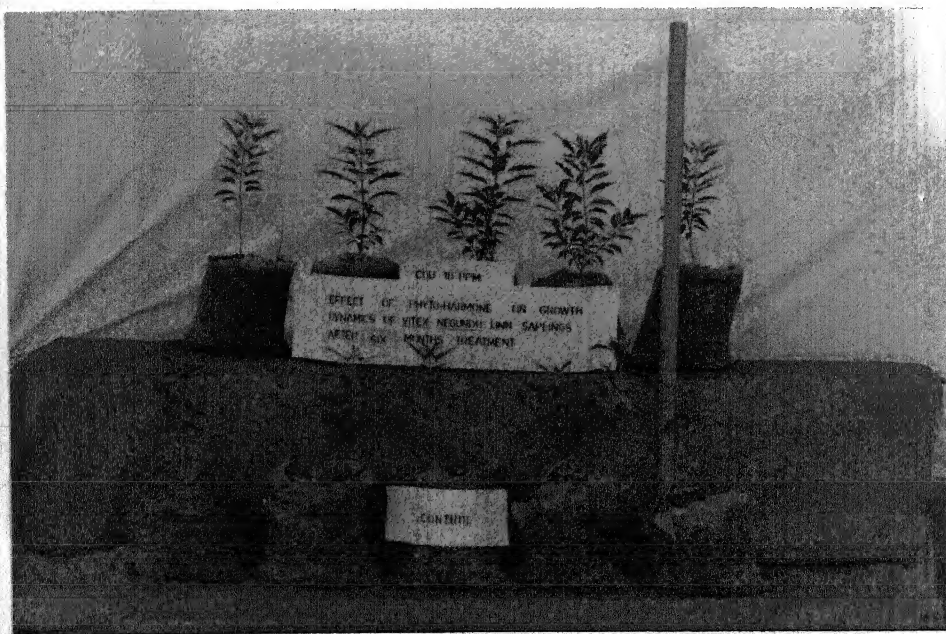


PLATE - 23: COU 10ppm : Effect of phytohormone on growth performance of ***Vitex negundo*** Linn sapling after six month treatment.

PLATE - 24: COU 100ppm : Effect of phytohormone on growth performance of ***Vitex negundo*** Linn sapling after six month treatment.

The growth of *V. negundo* was markedly affected by phytohormones as indicated by computing RGR, NAR and LAR. Data on RGR, NAR, and LAR are presented in Table 7.30, 7.31 & 7.32 and fig 7.18, 7.19 & 7.20 respectively.

RGR

The maximum RGR of 3 month old treated seedlings was obtained in IAA 100ppm + GA₃ 10 ppm and IAA 10 ppm + GA₃ 100 ppm concentrations, and minimum in MH 10 ppm concentration. In 6 month old treatment it was maximum in IAA 100 ppm + GA₃ 100 ppm concentration and minimum in IAA 10 ppm and COU 100 ppm concentration.

NAR

In 3 months old treated seedlings NAR was maximum in GA₃ 10 ppm concentration followed by IAA 10 ppm and minimum in MH 10 ppm and 100 ppm concentration. In 6 month old treated seedling NAR was maximum in GA₃ 100 ppm concentration followed by IAA 100 ppm + GA₃ 100 ppm and minimum in IAA 10 ppm + GA₃ 10 ppm concentration.

LAR

In 3 months old treated seedlings the maximum LAR was obtained

Table 7.30 RGR (mg/g/month) of *Vitex negundo* L. seedlings under various hormone treatments.

Hormone Concentrations	RGR (mg/g/month)	
	3 months	6 months
IAA (10ppm)	300	280
IAA (100ppm)	270	380
GA ₃ (10ppm)	300	310
GA ₃ (100ppm)	260	340
IAA+GA ₃ (10ppm+10ppm)	300	340
IAA+GA ₃ (10ppm+100ppm)	300	340
IAA+GA ₃ (100ppm+10ppm)	220	400
IAA+GA ₃ (100ppm+100ppm)	180	410
COU (10ppm)	160	370
COU (100ppm)	280	280
MH (10ppm)	90	380
MH (100ppm)	100	380
Control	160	340

Legends :-

IAA = Indole acetic acid

GA₃ = Gibberellic acid

COU = Coumarin

MH = Maleic hydrazide

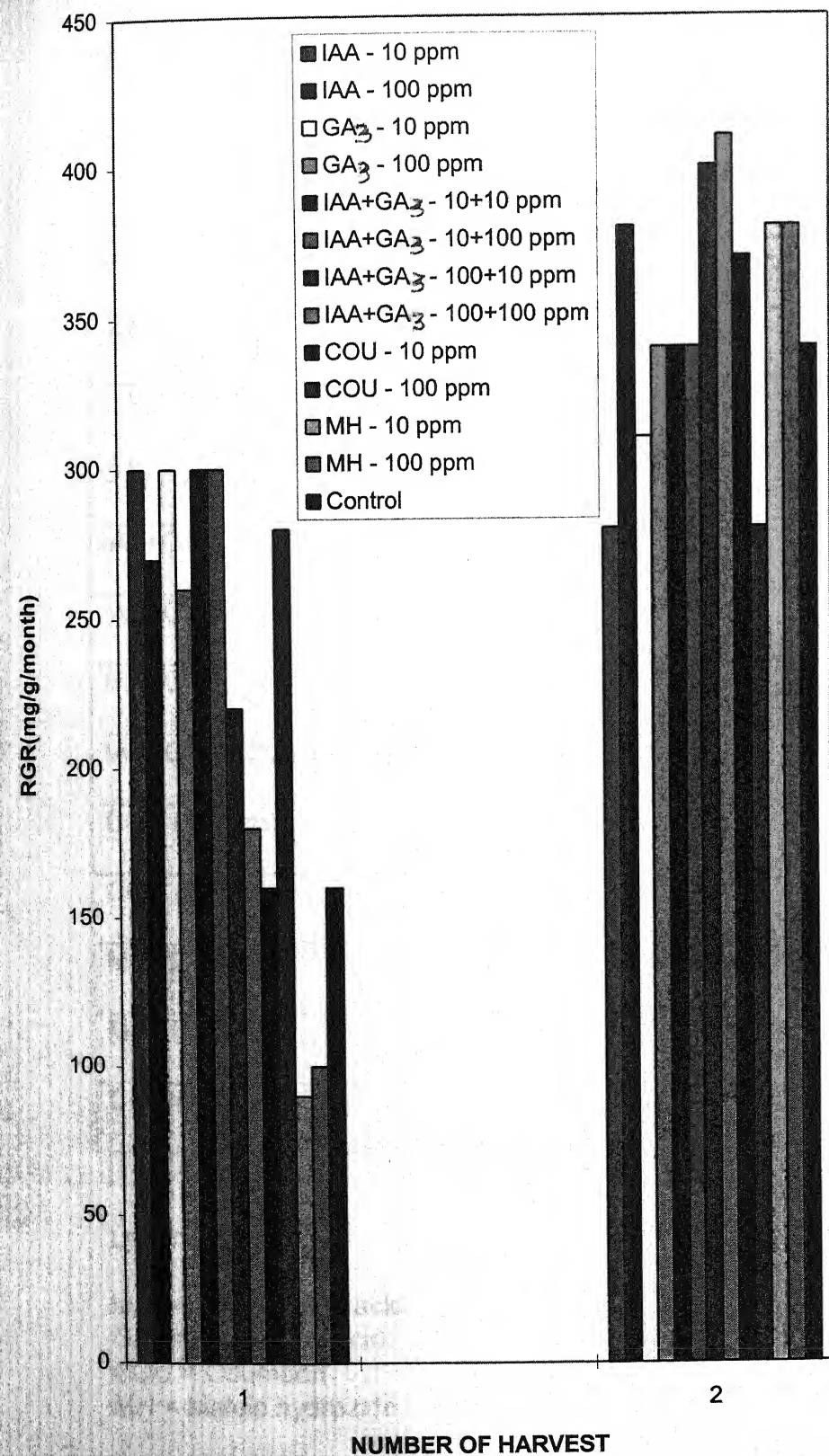


Figure 7.18 RGR of *Vitex negundo* seedlings under some phytohormone treatments.

Table 7.31 NAR (mg/cm²/month) of *Vitex negundo* L. seedlings under various hormone treatments.

Hormone Concentrations	NAR (mg/cm ² /month)	
	3 months	6 months
IAA (10ppm)	4.4	5.4
IAA (100ppm)	4.1	7.2
GA ₃ (10ppm)	4.8	7.6
GA ₃ (100ppm)	4.3	10.2
IAA+GA ₃ (10ppm+10ppm)	4.1	4.2
IAA+GA ₃ (10ppm+100ppm)	4.3	6.1
IAA+GA ₃ (100ppm+10ppm)	3.2	7.7
IAA+GA ₃ (100ppm+100ppm)	2.8	8.7
COU (10ppm)	2.1	6.7
COU (100ppm)	3.7	4.9
MH (10ppm)	1.2	7.4
MH (100ppm)	1.2	5.8
Control	1.5	4.8

Legends :-

IAA = Indole acetic acid

GA₃ = Gibberellic acid

COU = Coumarin

MH = Maleic hydrazide

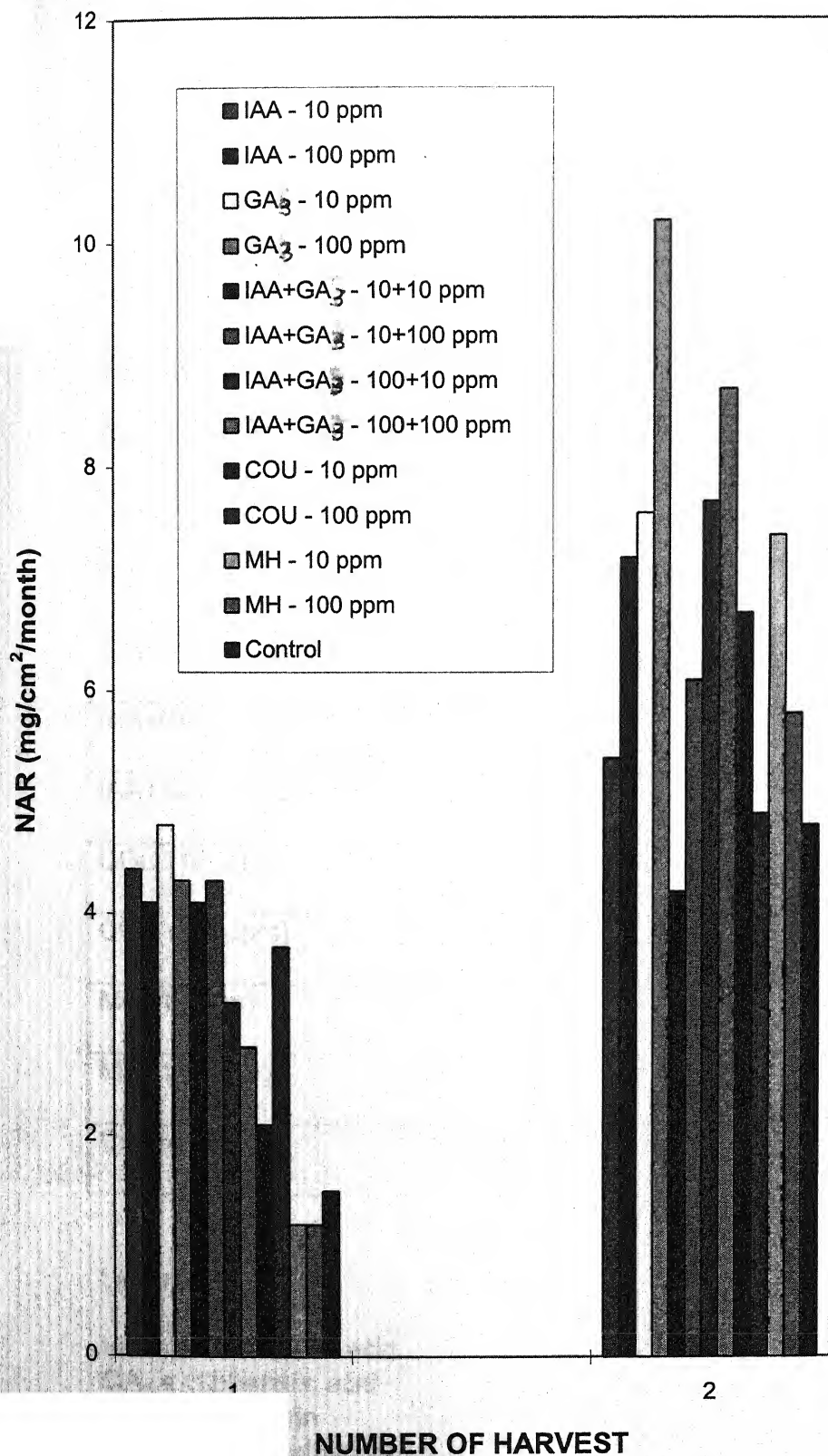


Figure 7.19 NAR of *Vitex negundo* seedlings under some phytohormone treatments.

Table 7.32 LAR (cm²/g) of *Vitex negundo* L. seedlings under various hormone treatments.

Hormone Concentrations	LAR (cm ² /g)	
	3 months	6 months
IAA (10ppm)	67.10	50.90
IAA (100ppm)	65.26	52.96
GA ₃ (10ppm)	63.11	40.60
GA ₃ (100ppm)	61.15	33.30
IAA+GA ₃ (10ppm+10ppm)	72.43	80.23
IAA+GA ₃ (10ppm+100ppm)	68.52	56.06
IAA+GA ₃ (100ppm+10ppm)	70.46	52.03
IAA+GA ₃ (100ppm+100ppm)	67.00	47.05
COU (10ppm)	75.75	54.44
COU (100ppm)	77.45	57.86
MH (10ppm)	84.43	36.07
MH (100ppm)	85.08	66.46
Control	105.26	69.73

Legends :-

IAA = Indole acetic acid

GA₃ = Gibberellic acid

COU = Coumarin

MH = Maleic hydrazide

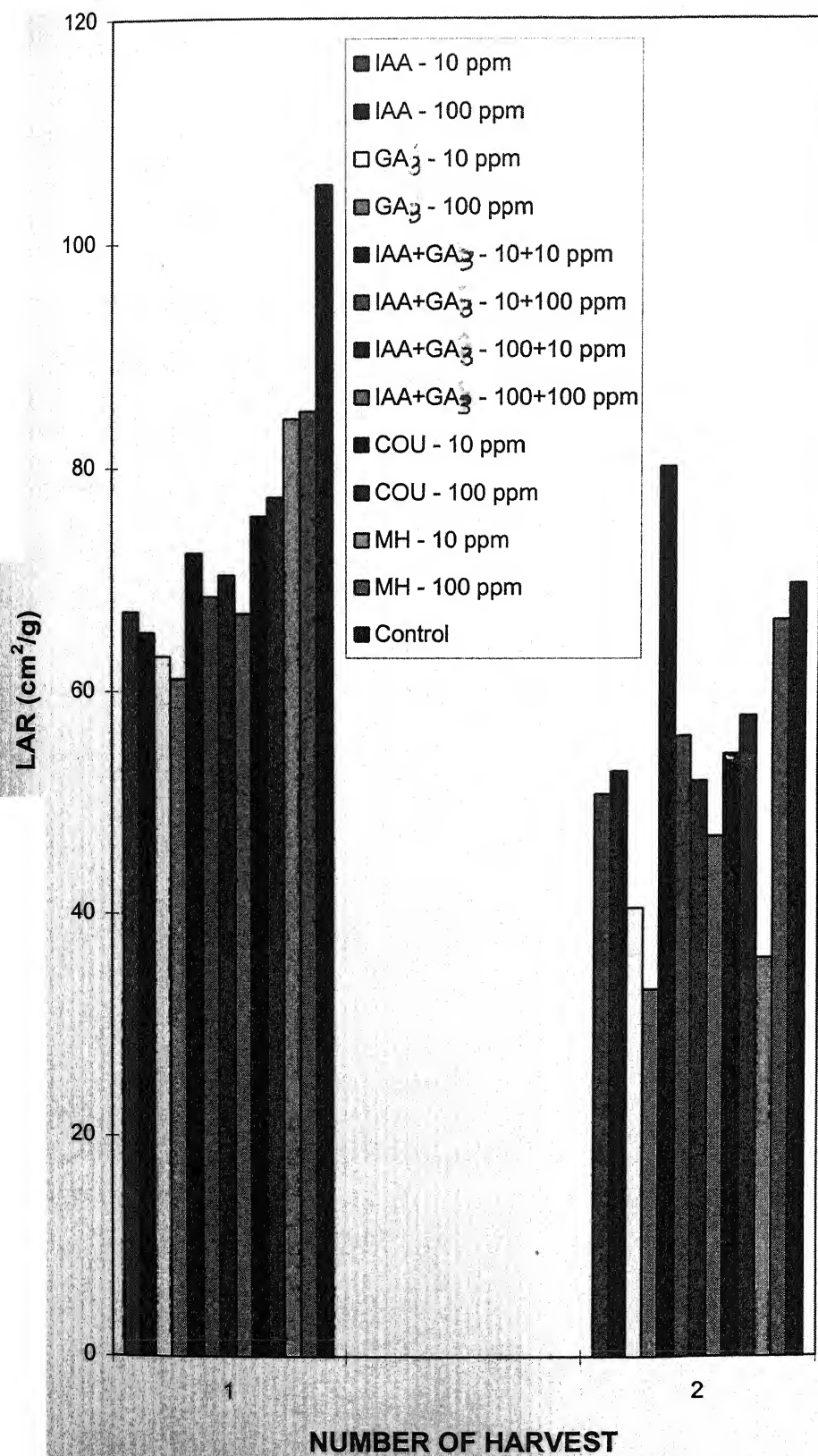
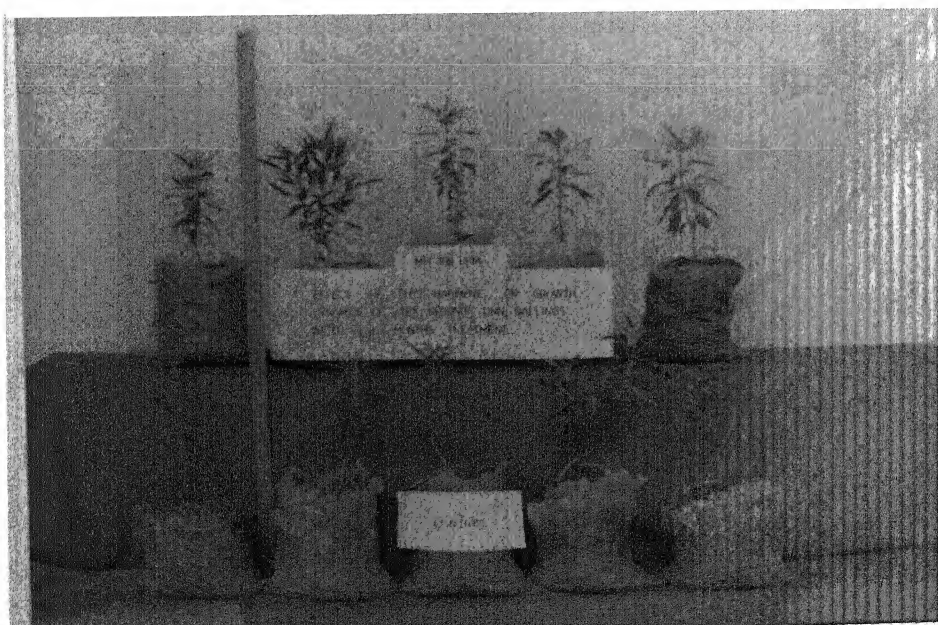
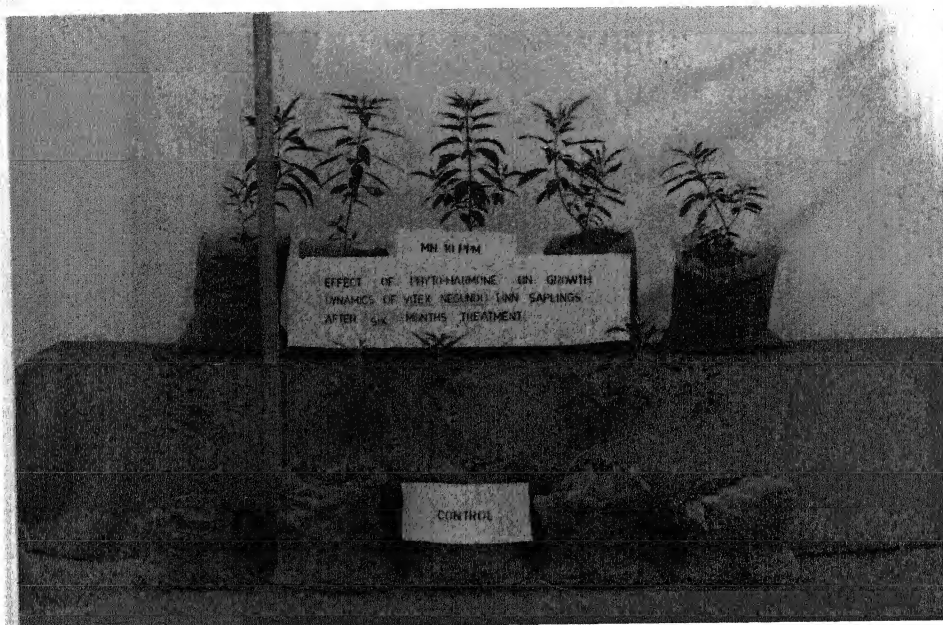


Figure 7.20 LAR of *Vitex negundo* seedlings under some phytohormone treatments.

PLATE - 25:MH 10ppm : Effect of phytohormone on growth performance of *Vitex negundo* Linn sapling after six month treatment.

PLATE - 26: MH 100ppm : Effect of phytohormone on growth performance of *Vitex negundo* Linn saplings after six month treatment.



in control. This was followed by MH 100 ppm concentration. Minimum was recorded in GA₃ 100 ppm concentration. In 6 months old treated seedlings LAR was maximum in IAA 10 ppm + GA₃ 10 ppm concentration followed by control and was minimum in GA₃ 100 ppm concentration.

Plant growth regulators have been reported to play a major role in initiating growth of seedlings. Gibberellic acid at high concentration stimulated plant length. In contrast, MH exerted a marked inhibitory effect on seedling growth.

Results indicate that IAA 10 ppm + GA₃ 10 ppm at low concentration was more effective in increasing the collar circumference, number of leaves and leaf area. The number of lateral roots show promotary effect at IAA 10 ppm + GA₃ 100 ppm concentration.

IAA at high concentration and GA₃ at low concentration showed promotary response to root and stem dry weight respectively. MH at low concentration showed inhibitory effect on plant length, collar circumference, number of leaves, leaf area and dry matter production of leaves as well. But its high concentration was inhibitory which reduced the number of lateral roots, and biomass of root and stem .

PLATE - 27: Effect of various combination of inorganic fertilizer ($N_1 P_0$) on growth performance of ***Vitex negundo*** Linn saplings (six month treatment).

PLATE - 28: Effect of various combination of inorganic fertilizer ($N_2 P_0$) on growth performance of ***Vitex negundo*** Linn saplings (six month treatment).

PLATE - 27: Effect of various combination of inorganic fertilizer ($N_1 P_0$) on growth performance of ***Vitex negundo*** Linn saplings (six month treatment).

PLATE - 28: Effect of various combination of inorganic fertilizer ($N_2 P_0$) on growth performance of ***Vitex negundo*** Linn saplings (six month treatment).



Nutrients often become deficient in soil and affect plant growth and seed production. Effects of inorganic fertilizers in many plants have been attempted in various field experiments by **Wallace and Pate** 1967; **Olday et al** 1976, **Rai and Patil** 1986; **Pal and Rawat** 1989 and **Ogbonnaya**, 1992, **Syvertsen and Smith** 1996; and **Tallowin**, and **Brookman**, 1996.

Plant Growth Performance

Data on growth performance of harvested seedlings are presented in Table 7.33, 7.34, 7.35, 7.36 & 7.37, which reveal the role of macronutrients in plant growth. The maximum plant length was obtained in N_0P_1 treated seedlings, while minimum was recorded in N_2P_0 seedlings (fig 7.21).

Collar circumference of the treated seedlings was maximum in N_2P_2 and minimum in control. Number of lateral roots was highest in N_2P_0 and lowest in control. Number and area of leaves also indicate similar trends as of collar circumference.

Dry Matter Production

Table 7.37 & Fig 7.22 indicates dry weights of root and stem were maximum in N_2P_0 and minimum in control; While dry weight of leaves was maximum in N_2P_2 and minimum in control.

TABLE - 7.33 Effect of various combinations of nitrogen (N) and phosphorus (p) on total length (cm) of *Vitex negundo* L. seedlings *.

N, P Combinations	Seedlings harvested after	
	3 months	6 months
N ₁ P ₀	43.60	55.80
N ₂ P ₀	45.80	55.20
N ₃ P ₀	42.80	55.00
N ₁ P ₁	42.00	64.60
N ₂ P ₁	45.20	55.20
N ₃ P ₁	43.80	63.80
N ₁ P ₂	45.00	54.40
N ₂ P ₂	45.40	61.20
N ₃ P ₂	35.60	50.40
N ₀ P ₁	54.40	65.60
N ₀ P ₂	43.70	64.20
Control	35.80	60.80
SEm ±	0.49	1.33
C.D. 0.05	0.96	2.61

* Average of 5 plants per treatment

SEm = Standard error of mean C.D. = Critical difference

N₀ = Nitrogen nil

N₁ = 60 kg / ha

N₂ = 90 kg / ha

N₃ = 120 kg / ha

P₀ = Phosphorus nil

P₁ = 30 kg / ha

P₂ = 60 kg / ha

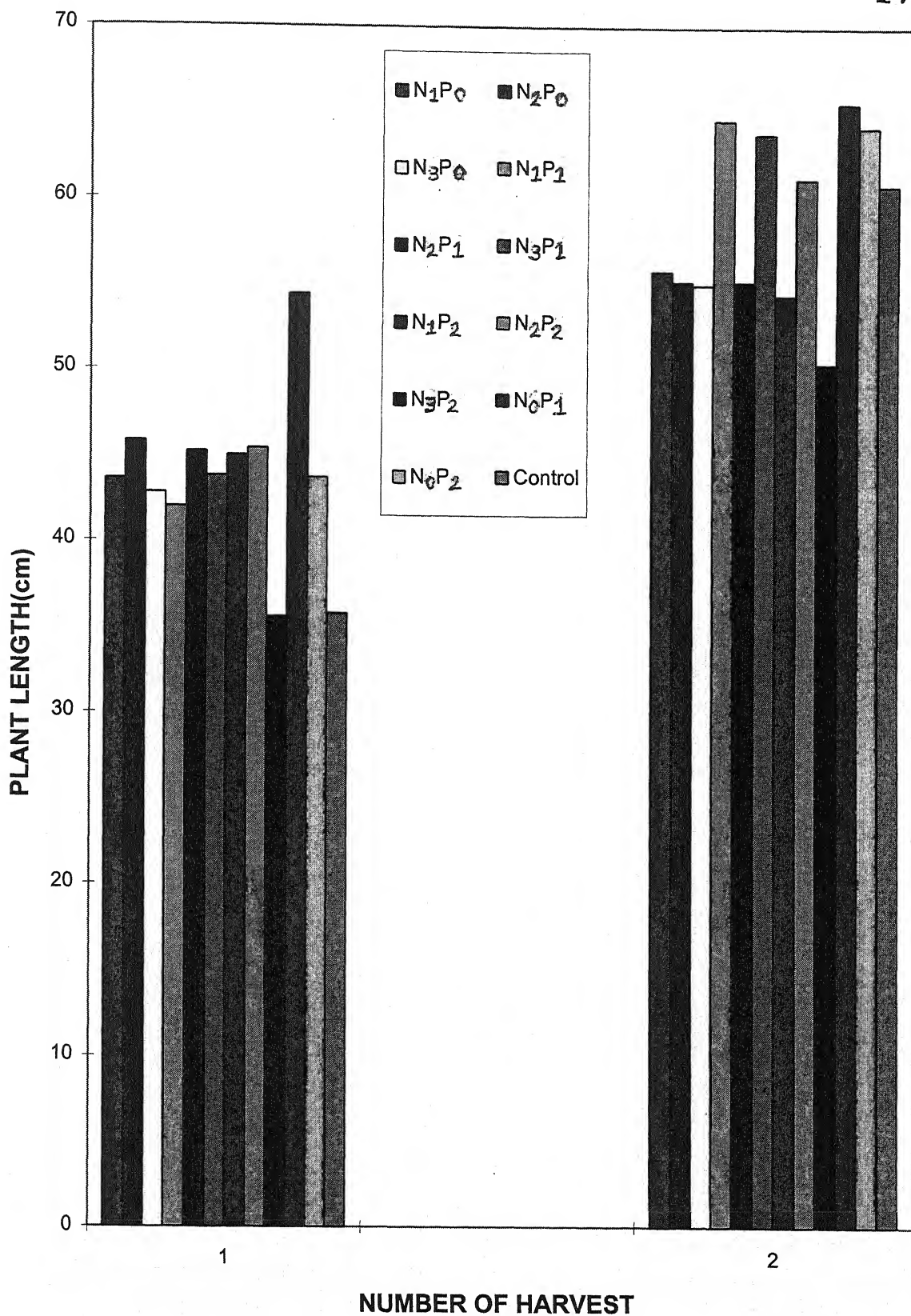
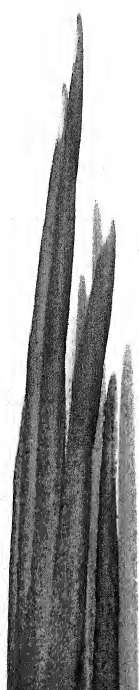


Figure 7.21 Total plant length of *Vitex negundo* seedlings under inorganic fertilizer treatments.

PLATE - 29: Effect of various combination of inorganic fertilizer ($N_3 P_0$) on growth performance of *Vitex negundo* Linn saplings (six month treatment).

PLATE - 30: Effect of various combination of inorganic fertilizer ($N_1 P_1$) on growth performance of *Vitex negundo* Linn sapling (six month treatment).



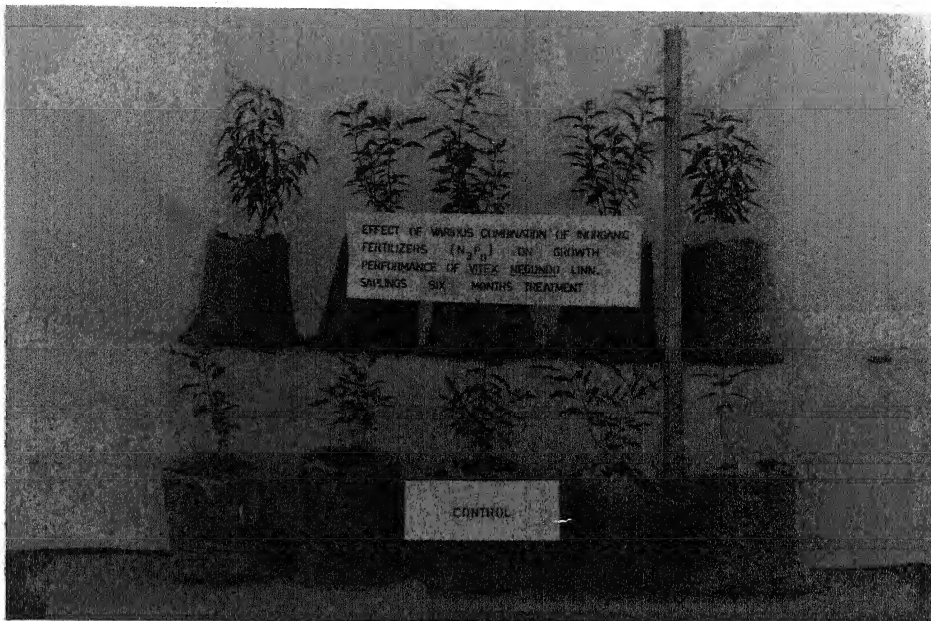


TABLE - 7.34 Effect of various combinations of nitrogen (N) and phosphorus (p) on collar circumference (cm) of *Vitex negundo* L. seedlings *.

N, P Combinations	Seedlings harvested after	
	3 months	6 months
N ₁ P ₀	1.14	1.50
N ₂ P ₀	1.48	1.80
N ₃ P ₀	1.14	1.40
N ₁ P ₁	1.50	2.10
N ₂ P ₁	1.34	1.40
N ₃ P ₁	1.20	1.40
N ₁ P ₂	1.34	1.60
N ₂ P ₂	1.52	2.40
N ₃ P ₂	1.22	1.70
N ₀ P ₁	1.38	2.10
N ₀ P ₂	1.34	1.90
Control	0.66	1.20
SEm ±	0.04	0.08
C.D. 0.05	0.08	0.15

* Average of 5 plants per treatment

SEm = Standard error of mean C.D. = Critical difference

N₀ = Nitrogen nil

N₁ = 60 kg / ha

N₂ = 90 kg / ha

N₃ = 120 kg / ha

P₀ = Phosphorus nil

P₁ = 30 kg / ha

P₂ = 60 kg / ha

TABLE - 7.35 Effect of various combinations of nitrogen (N) and phosphorus (p) on number of lateral roots of *Vitex negundo* L. seedlings *.

N, P Combinations	Seedlings harvested after	
	3 months	6 months
N ₁ P ₀	14.40	26.60
N ₂ P ₀	18.40	29.40
N ₃ P ₀	11.80	22.60
N ₁ P ₁	17.20	21.00
N ₂ P ₁	15.80	22.20
N ₃ P ₁	14.80	17.80
N ₁ P ₂	10.80	15.00
N ₂ P ₂	15.20	28.20
N ₃ P ₂	13.00	17.60
N ₀ P ₁	17.80	25.80
N ₀ P ₂	17.80	18.20
Control	10.40	13.20
SEm ±	0.55	0.92
C.D. 0.05	1.08	1.80

* Average of 5 plants per treatment

SEm = Standard error of mean C.D. = Critical difference

N₀ = Nitrogen nil

N₁ = 60 kg / ha

N₂ = 90 kg / ha

N₃ = 120 kg / ha

P₀ = Phosphorus nil

P₁ = 30 kg / ha

P₂ = 60 kg / ha

PLATE - 31: Effect of various combination of inorganic fertilizer ($N_2 P_1$) on growth performance of *Vitex negundo* Linn sapling (six month treatment).

PLATE -32: Effect of various combination of inorganic fertilizer ($N_3 P_1$) on growth performance of *Vitex negundo* Linn sapling (six month treatment).



TABLE- 7.36 Effect of various combinations of nitrogen (N) and phosphorus (p) on number of leaves and leaf area (cm²) of *Vitex negundo* L. seedlings *.

N, P Combinations	Seedlings harvested after			
	3 months		6 months	
	Leaves		Leaves	
	Number	Area	Number	Area
N ₁ P ₀	25.00	154.89	92.00	315.98
N ₂ P ₀	29.20	255.07	89.40	351.92
N ₃ P ₀	27.80	144.14	98.00	360.52
N ₁ P ₁	26.00	353.64	89.20	476.93
N ₂ P ₁	28.80	222.34	99.60	623.69
N ₃ P ₁	25.60	134.41	96.40	548.05
N ₁ P ₂	39.40	264.66	95.60	494.80
N ₂ P ₂	62.20	699.98	119.80	745.97
N ₃ P ₂	38.10	258.42	91.80	497.78
N ₀ P ₁	51.20	553.04	101.40	675.72
N ₀ P ₂	54.60	328.27	86.00	488.80
Control	16.00	58.08	50.20	162.60
SEm ±	0.57	0.24	2.18	10.96
C.D. 0.05	1.12	0.47	4.28	21.49

* Average of 5 plants per treatment

SEm = Standard error of mean C.D. = Critical difference

N₀ = Nitrogen nil

N₁ = 60 kg / ha

N₂ = 90 kg / ha

N₃ = 120 kg / ha

P₀ = Phosphorus nil

P₁ = 30 kg / ha

P₂ = 60 kg / ha

TABLE - 7.37 Effect of various combinations of nitrogen (N) and phosphorus (p) on dry matter production (g) of *Vitex negundo* L. seedlings *.

N, P Combinations	Seedlings harvested after					
	3 months			6 months		
	R	S	L	R	S	L
N ₁ P ₀	0.95	0.36	0.67	2.65	1.42	2.35
N ₂ P ₀	1.30	0.47	0.95	3.59	2.33	2.64
N ₃ P ₀	0.81	0.29	0.62	2.24	1.54	2.68
N ₁ P ₁	0.90	0.40	0.85	3.19	2.09	4.05
N ₂ P ₁	0.93	0.39	0.89	2.94	2.24	3.70
N ₃ P ₁	0.66	0.30	0.67	2.19	1.62	4.00
N ₁ P ₂	0.84	0.26	0.69	2.93	1.96	3.71
N ₂ P ₂	0.59	0.26	1.11	3.24	2.22	4.95
N ₃ P ₂	0.47	0.22	0.49	2.50	2.06	3.24
N ₀ P ₁	1.26	0.45	0.60	3.16	2.26	3.38
N ₀ P ₂	0.75	0.35	0.86	2.28	1.66	2.58
Control	0.19	0.09	0.18	1.74	0.99	1.97
SEm ±	0.01	0.01	0.01	0.08	0.004	0.11
C.D. 0.05	0.012	0.012	0.012	0.16	0.01	0.21

* Average of 5 plants per treatment

SEm = Standard error of mean C.D. = Critical difference

N₀ = Nitrogen nil N₁ = 60 kg / ha N₂ = 90 kg / ha

N₃ = 120 kg / ha P₀ = Phosphorus nil P₁ = 30 kg / ha

P₂ = 60 kg / ha

Legends: R = Root S = Stem L = Leaves

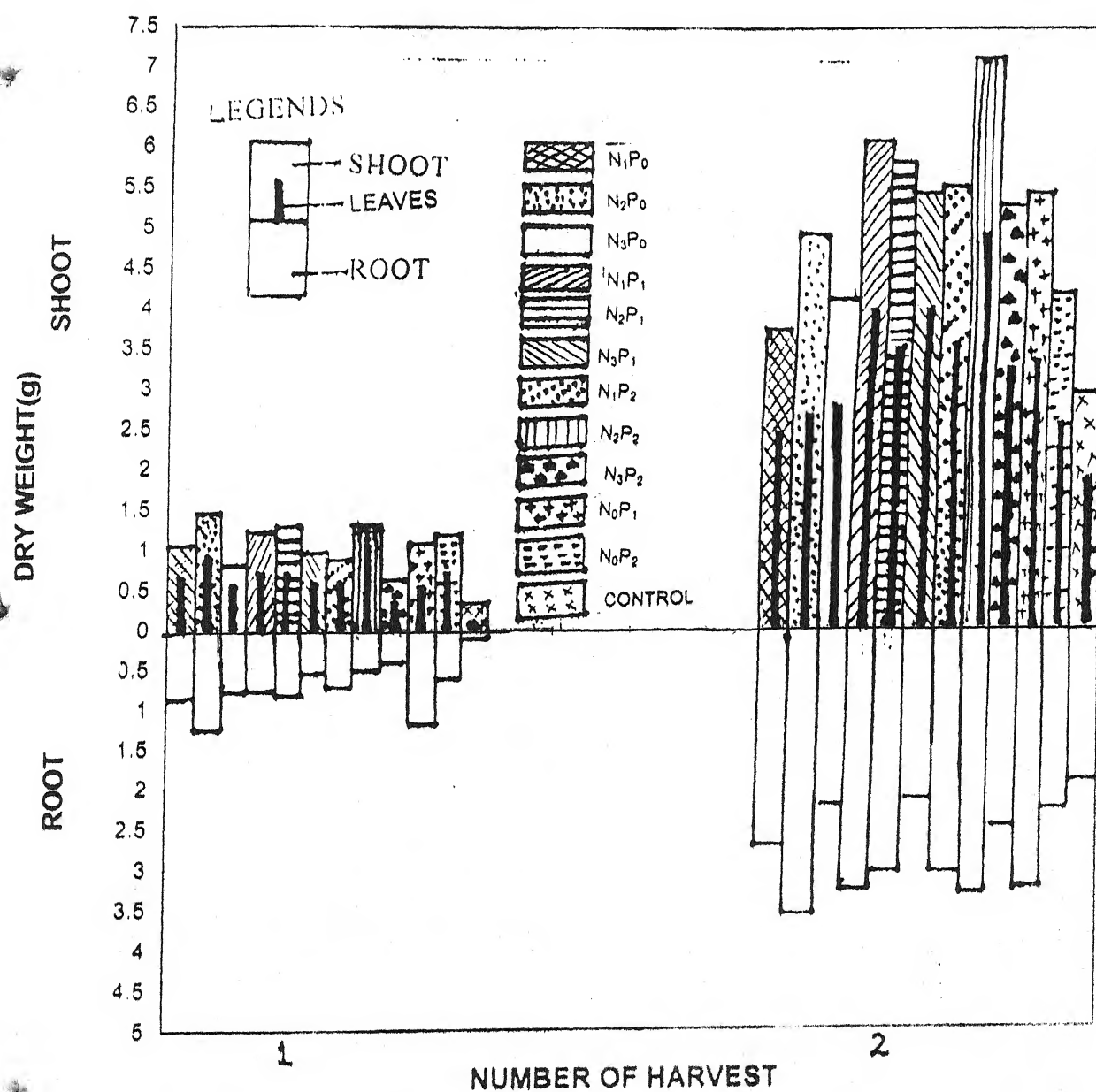


Figure 7.22 dry matter production of *Vitex negundo* seedlings under inorganic fertilizer treatment

PLATE - 33: Effect of various combination of inorganic fertilizer ($N_1 P_2$) on growth performance of ***Vitex negundo*** Linn saplings (six month treatment).

PLATE - 34: Effect of various combination of inorganic fertilizer ($N_2 P_2$) on growth performance of ***Vitex negundo*** Linn saplings (six month treatment).



TABLE - 7.38 RGR (mg / g / month) of *Vitex negundo* L. seedlings under inorganic fertilizers (nitrogen and phosphorus) treatment

N, P Combinations	RGR (mg/g/month)	
	3 months	6 months
N ₁ P ₀	370	170
N ₂ P ₀	420	170
N ₃ P ₀	350	190
N ₁ P ₁	380	220
N ₂ P ₁	390	200
N ₃ P ₁	340	230
N ₁ P ₂	360	230
N ₂ P ₂	330	280
N ₃ P ₂	300	270
N ₀ P ₁	420	160
N ₀ P ₂	370	170
Control	160	340

N₀ = Nitrogen nil

N₃ = 120 kg / ha

P₂ = 60 kg / ha

N₁ = 60 kg / ha

P₀ = Phosphorus nil

N₂ = 90 kg / ha

P₁ = 30 kg / ha

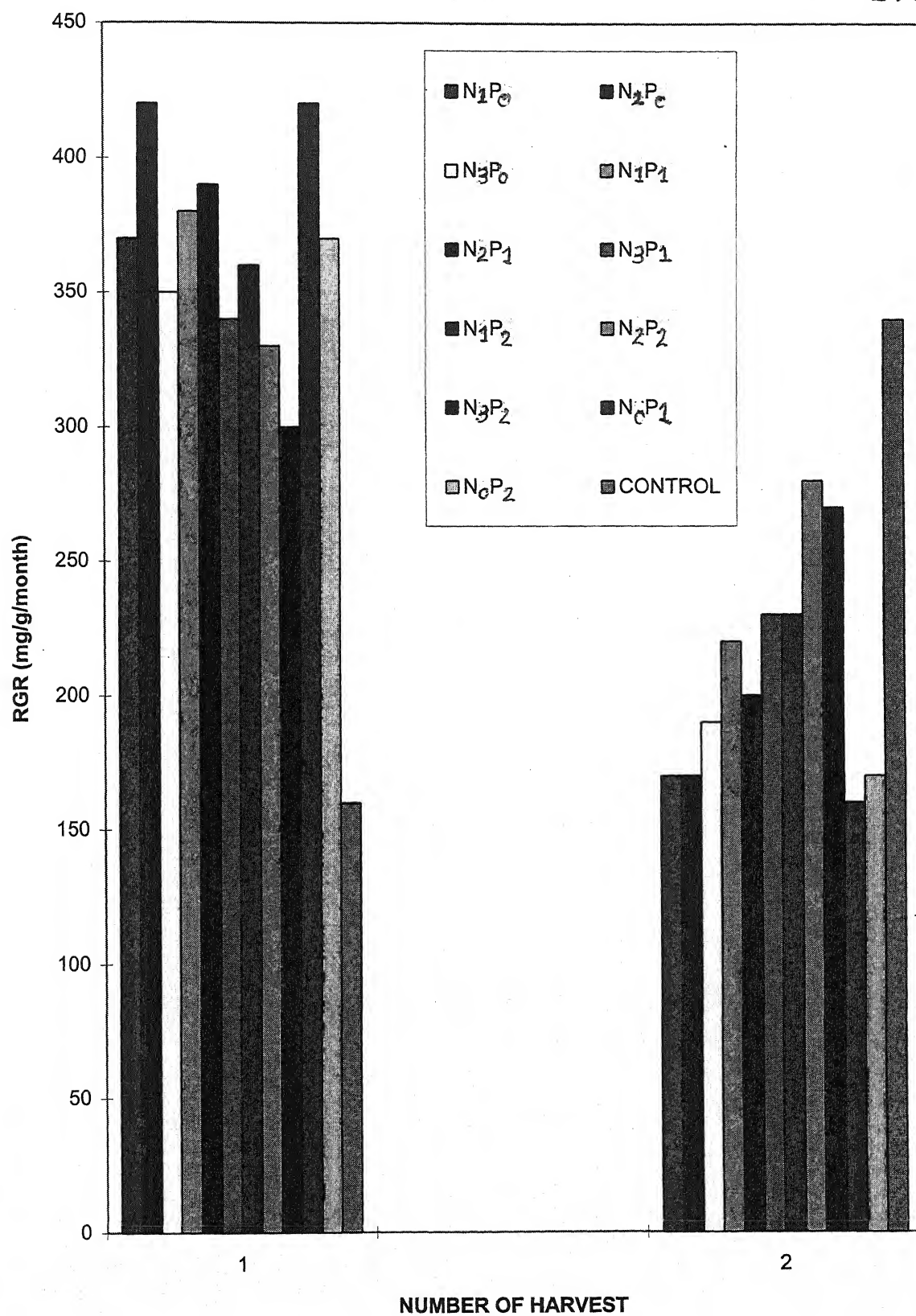


Figure 7.23 RGR of *Vitex negundo* seedlings under inorganic fertilizer treatments.

TABLE - 7.39 NAR (mg /cm² / month) of *Vitex negundo* L. seedlings under inorganic fertilizers (nitrogen and phosphorus) treatment

N, P Combinations	NAR (mg /cm ² / month)	
	3 months	6 months
N ₁ P ₀	4.7	2.8
N ₂ P ₀	4.7	2.8
N ₃ P ₀	4.3	2.9
N ₁ P ₁	2.9	2.7
N ₂ P ₁	4.2	2.5
N ₃ P ₁	4.2	3.0
N ₁ P ₂	2.9	2.7
N ₂ P ₂	1.1	1.8
N ₃ P ₂	1.8	2.6
N ₀ P ₁	2.7	1.4
N ₀ P ₂	2.7	1.6
Control	1.5	6.0

N₀ = Nitrogen nil
 N₃ = 120 kg / ha
 P₂ = 60 kg / ha

N₁ = 60 kg / ha
 P₀ = Phosphorus nil

N₂ = 90 kg / ha
 P₁ = 30 kg / ha

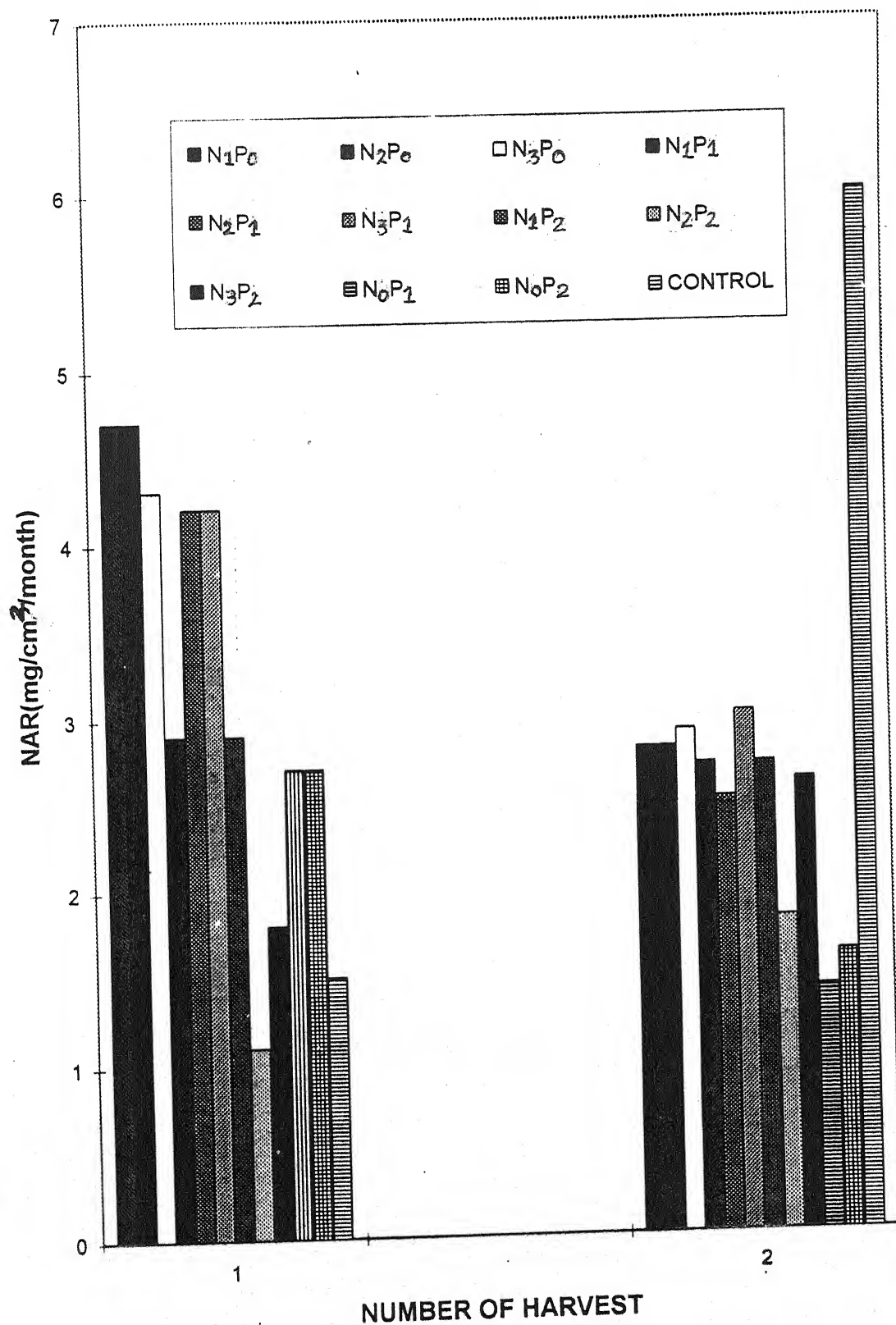
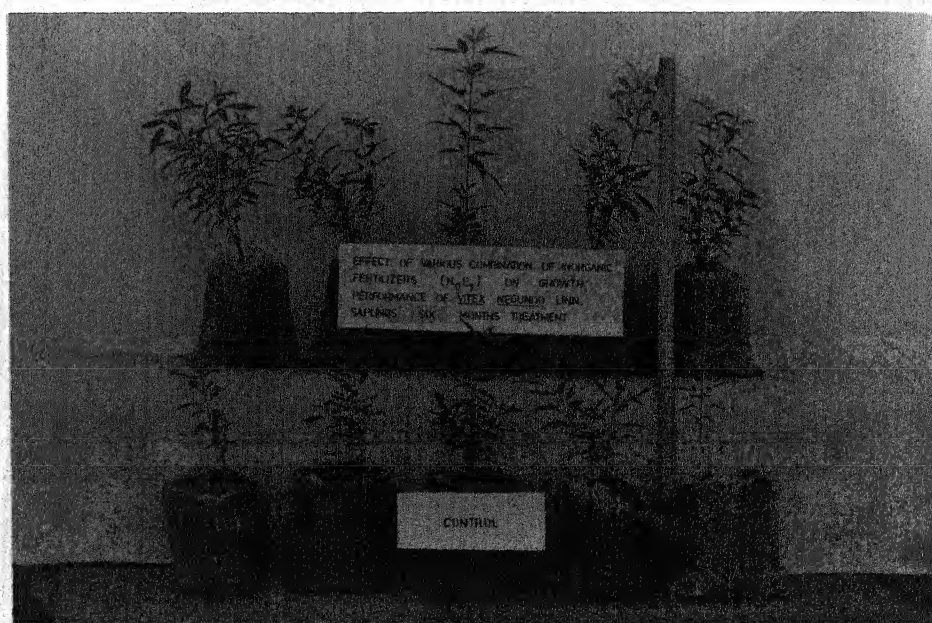


Figure 7.24 NAR of *Vitex negundo* seedlings under inorganic fertilizer treatments.

PLATE - 35: Effect of various combination of inorganic fertilizer ($N_3 P_2$) on growth performance of ***Vitex negundo*** Linn saplings (six month treatment).

PLATE - 36: Effect of various combination of inorganic fertilizer ($N_0 P_1$) on growth performance of ***Vitex negundo*** Linn sapling (six month treatment).



Data on LAR are presented in Table 7.40 & fig 7.25. The LAR of the treated seedlings was maximum in N_2P_2 . It was, however, minimum in N_1P_0 and control respectively when computed in the seedlings of second harvest.

The present investigations indicate that when nitrogen (N_2) was used solely, it increased the number of roots, root and stem weight etc; whereas when used in combination with phosphorus (P_2) it increased the collar circumference, number and dry weight of leaves including leaf area.

Ezenwa (1994) reported that phosphorus at 7.5 mg/kg soil significantly increase number and dry weight of nodules and shoot height over control, but had no effect on root growth.

Reed and Hagerman (1990) observed that increased nitrogen concentration cause increase in shoot dry weight but have no effect on the dry weight of root.

Maximum stem height and diameter growth ensued at optimum nitrogen nutrition. The total fresh weight of the seedlings did not increase with the increase in nitrogen from sub optimum to optimum level. At supra optimum level the dry weight declined considerably. The total dry weight increase if nitrogen is added upto optimum level. When it is further increased upto supra optimal level, it

TABLE - 7.40 LAR (cm^2 / g) of *Vitex negundo* L. seedlings under inorganic fertilizers (nitrogen and phosphorus) treatment

N, P Combinations	LAR (cm^2 / g)	
	3 months	6 months
N ₁ P ₀	78.52	59.86
N ₂ P ₀	89.41	59.07
N ₃ P ₀	82.33	65.89
N ₁ P ₁	134.08	82.10
N ₂ P ₁	93.82	80.64
N ₃ P ₁	81.42	74.62
N ₁ P ₂	123.13	93.41
N ₂ P ₂	294.60	159.01
N ₃ P ₂	160.31	104.16
N ₀ P ₁	154.83	116.53
N ₀ P ₂	135.35	106.28
Control	105.26	55.65

N₀ = Nitrogen nil
 N₃ = 120 kg / ha
 P₂ = 60 kg / ha

N₁ = 60 kg / ha
 P₀ = Phosphorus nil

N₂ = 90 kg / ha
 P₁ = 30 kg / ha

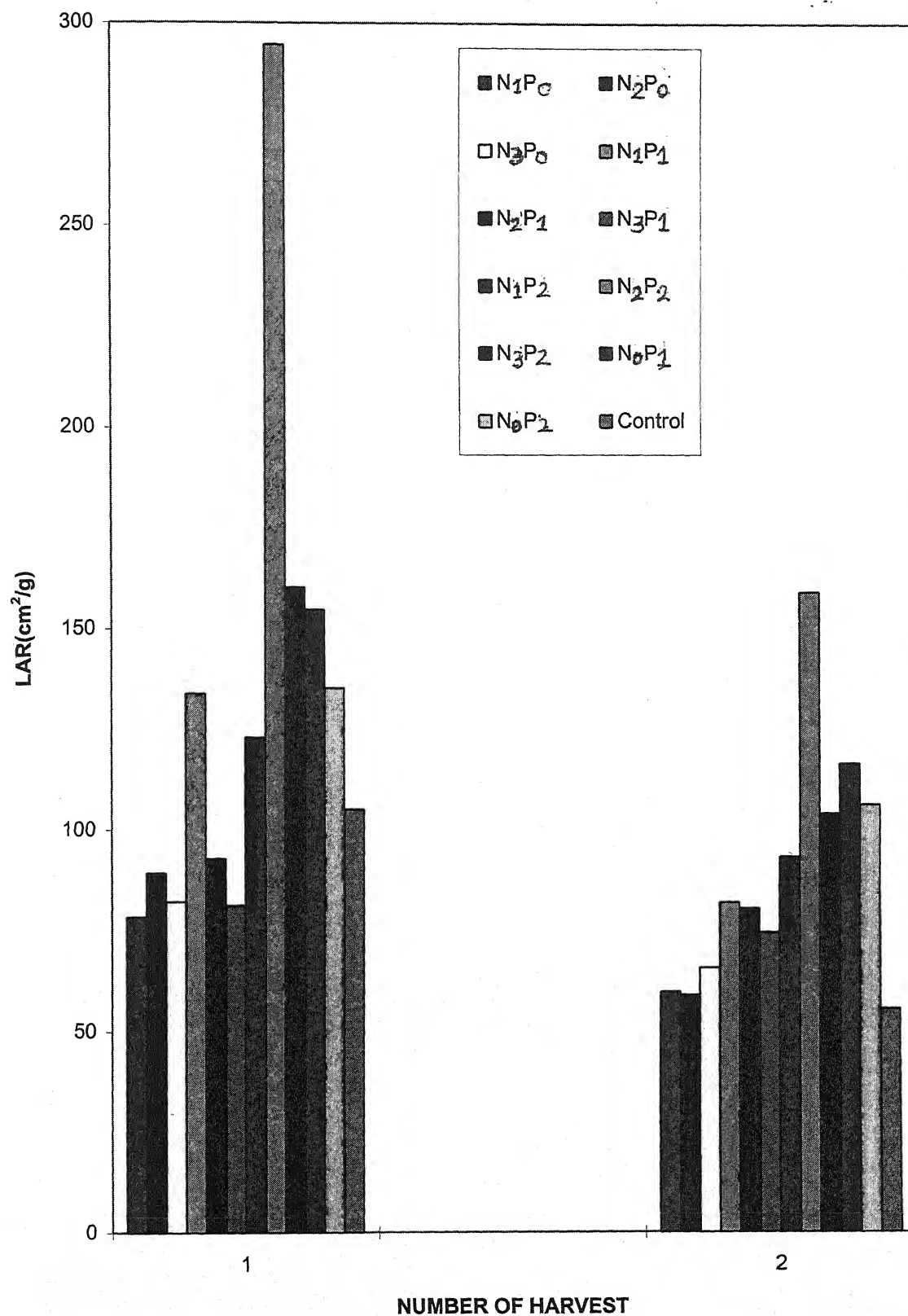
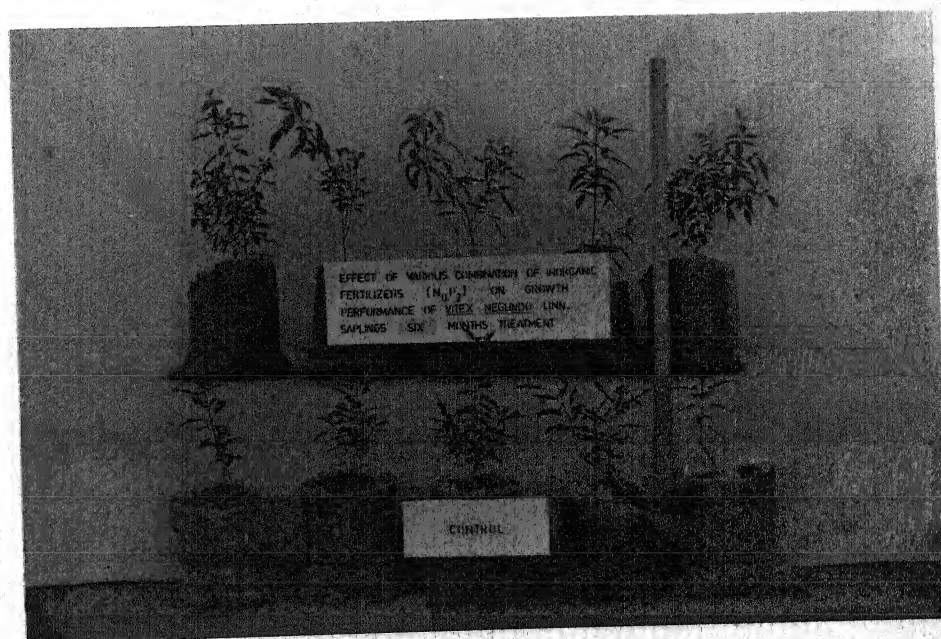


Figure 7.25 LAR of *Vitex negundo* seedlings under inorganic fertilizer treatment.

PLATE - 37: Effect of various combination of inorganic fertilizer ($N_0 P_2$) on growth performance of *Vitex negundo* Linn saplings (six month treatment).



usually caused considerable reduction in dry weight (Agrawal, 1983).

Maier et al. (1996) reported that application of nitrogen significantly increased the yield of stems and total stem yield in Australian wax flowers.

Schuch (1996) observed linear increase in the leaf area and leaf dry weight of *Poinsettia* ^{cultivars} in response to increasing nitrogen fertilizer concentrations.

(VI) Organic Manures

It is scientifically established fact that the plant growing after cultivation of pastures, when the soil is rich in organic manures, show better growth. Hence in order to understand the effect of organic manures this aspect was also considered. The growth behaviour of *V. negundo* plants in relation to various organic manures were studied. The results obtained are provided as below:-

Plant Growth Performance

By observing the Tables 7.41, 7.42, 7.43, 7.44 & 7.45 it is clear that all the growth parameters viz, total plant length, collar circumference, number of lateral roots, number of leaves including leaf area were maximum in soil mixed with goat faeces. However minimum growth of *V. negundo* seedlings were recorded in soil mixed with poultry farm waste. Overall performance of growth in

different manures were as follows :-

186

Total Plant length

Fig 7.26 indicates maximum plant length (87.20cm) was observed in soil mixed with goat faeces followed by cow dung treatment (79.00cm), while minimum plant length (41.60) was recorded in soil containing poultry waste.

Total plant length of *V.negundo* seedlings exhibited marked variation under different treatments of manures. In 3 months old treatment the seedling lengths were in the following descending order:-

Goat faeces > Cow dung > Control > Forest dry litter > Blood from slaughter house > water hyacinth > Bone meal > Poultry waste. However in six months old treatment the seedling lengths were in following descending order:-

Goat faeces > Cowdung > Bone meal > Forest dry litter > water hyacinth > Blood from slaughter house > Control > Poultry waste.

Collar circumference -

In 3 months old treated seedlings maximum collar circumference was also recorded in soil mixed with goat faeces followed by powder of water hyacinth and minimum in poultry waste. In 6 months treatment it was again maximum in goat faeces followed by cow dung and was minimum again in poultry waste.

Table - 7.41 Effect of organic manures on total length(cm) of *Vitex negundo* seedlings*.

Organic manures	Proportion in soil	Seedlings harvested after	
		3 months	6 months
Cow dung	20 g/kg	28.70	79.00
Goat faeces	20 g/kg	33.60	87.20
Poultry farm waste	20 g/kg	17.10	41.60
Bone meal	2 g/kg	18.20	59.40
Water hyacinth	5 g/kg	20.20	56.80
Forest dry litter	5 g/kg	26.40	58.60
Blood from slaughter house	3 g/kg	24.30	54.80
Control	—	26.90	45.60
SEm \pm	—	0.75	1.23
C. D. _{0.05}	—	1.53	2.53

* Average of 5 plants per treatment

SEm = Standard error of mean

C. D. = Critical difference

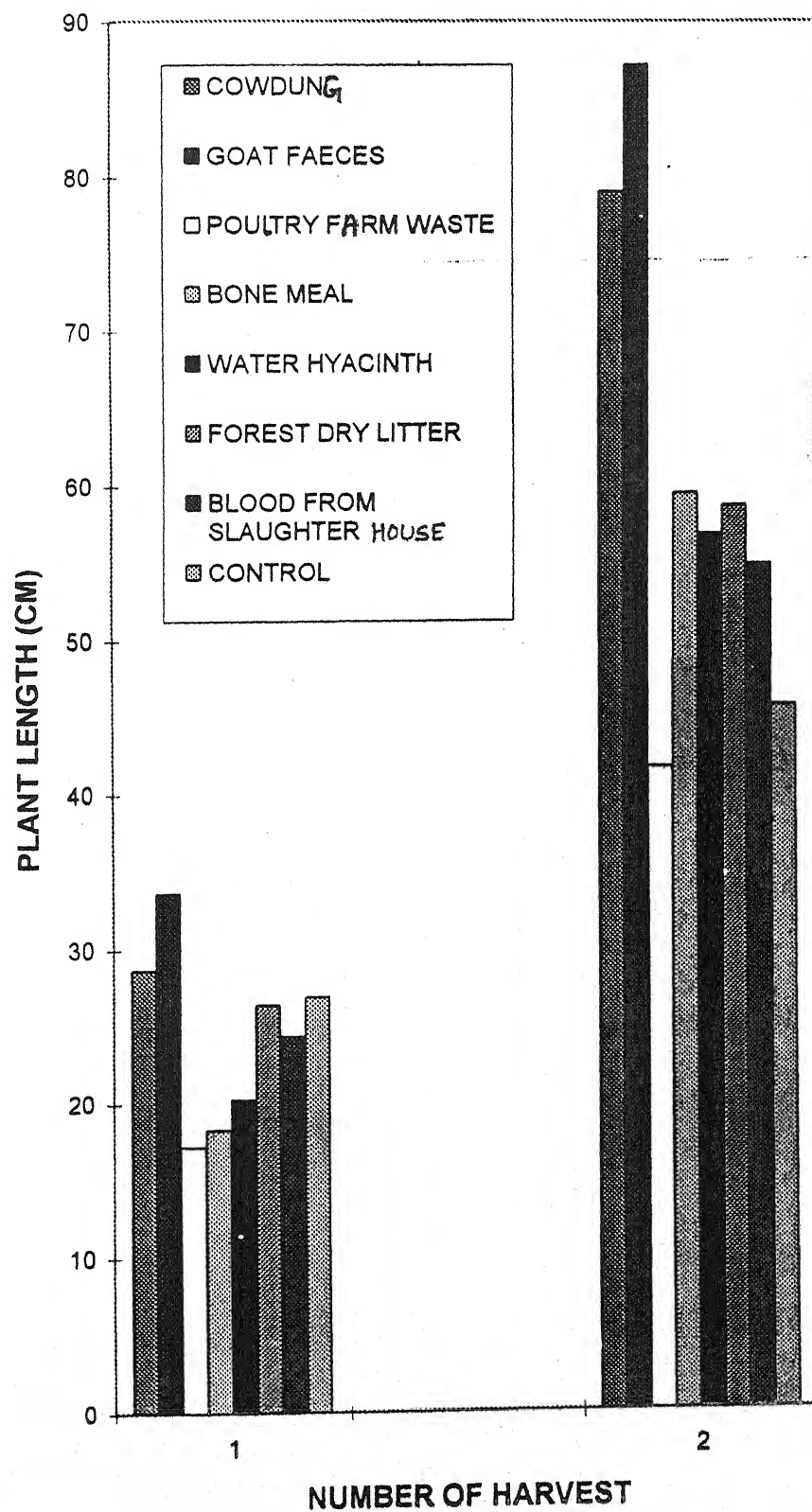


Figure 7.26 Total plant length of *Vitex negundo* seedlings under organic manure treatment.

PLATE - 38: COW DUNG: Effect of organic manures on growth performance of *Vitex negundo* Linn (Six month treatment).

PLATE - 39: GOAT FAECES: Effect of organic manures on growth performance of *Vitex negundo* Linn (Six month treatment).

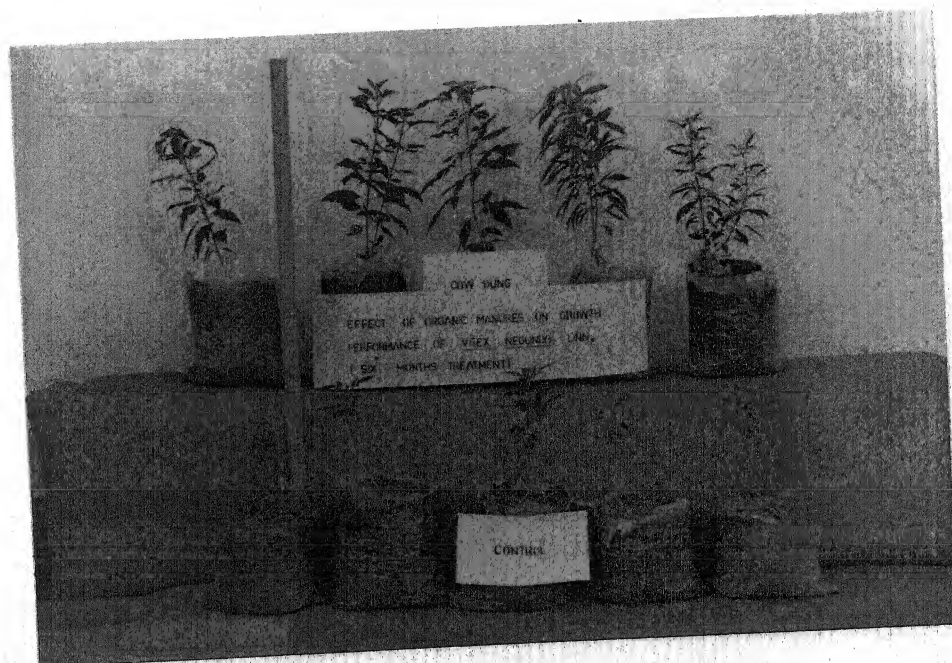


Table - 7.42 Effect of organic manures on collar circumference (cm) of *Vitex negundo* L. seedlings*

Organic manures	Proportion in soil	Seedlings harvested after	
		3 months	6 months
Cow dung	20 g/kg	0.80	2.08
Goat faeces	20 g/kg	0.98	2.12
Poultry farm waste	20 g/kg	0.54	1.02
Bone meal	2 g/kg	0.62	1.52
Water hyacinth	5 g/kg	0.94	1.62
Forest dry litter	5 g/kg	0.64	1.72
Blood from slaughter house	3 g/kg	0.82	1.40
Control	—	0.74	1.24
SEm \pm	—	0.06	0.06
C. D. 0.05	—	0.13	0.13

* Average of 5 plants per treatment

SEm = Standard error of mean

C. D. = Critical difference

The descending order of the collar circumference in the seedlings in 3 months old treatment of manures was as follows:-

Goat faeces > water hyacinth > Blood from slaughter house > Cowdung > Control > Forest dry litter > Bone meal > Poultry waste.

Whereas in 6 months old treatment it was :-

Goat faeces > Cow dung > Forest dry litter > Water hyacinth > Bone meal > Blood from slaughter house > Control > Poultry waste.

Number of lateral roots

Maximum number of lateral roots was observed in soil mixed with goat faeces, followed by soil mixed with cow dung in both 3 and 6 months old treatments. However, minimum number of lateral roots was recorded in poultry waste and in soil mixed with bone meal in 6 and 3 months old treated seedlings respectively. The number of lateral roots in 3 months old treated seedlings exhibited following order of decrease-

Goat faeces > Cowdung > Forests dry litter > water hyacinth > Blood from slaughter house > Control > Bone meal > Poultry waste.

Whereas, the descending order of lateral roots in 6 months old treated seedlings was as follows:-

Table - 7.43 Effect of organic manures on number of lateral roots of *Vitex negundo* L. seedlings*

Organic manures	Proportion in soil	Seedlings harvested after	
		3 months	6 months
Cow dung	20 g/kg	11.80	28.00
Goat faeces	20 g/kg	15.40	32.80
Poultry farm waste	20 g/kg	6.80	10.60
Bone meal	2 g/kg	6.80	19.40
Water hyacinth	5 g/kg	7.80	13.80
Forest dry litter	5 g/kg	10.40	26.40
Blood from slaughter house	3 g/kg	7.60	23.60
Control	—	7.00	13.20
SEm \pm	—	0.60	1.15
C. D. _{0.05}	—	1.23	2.36

* Average of 5 plants per treatment

SEm = Standard error of mean

C. D. = Critical difference

Goat faeces > Cow dung > Forest dry litter > Blood from slaughter house > Bone meal > water hyacinth > Control > Poultry waste.

Number of leaves

In 3 months old treated seedlings the number of leaves were maximum in soil mixed with goat faeces and minimum in soil mixed with poultry waste with the following descending order:-

Goat faeces > Forest dry litter > Water hyacinth > Cow dung > Bone meal > Blood from slaughter house > Control > Poultry waste.

The descending order of various manures as per the number of leaves produced in 6 months old treated seedlings was as under-

Goat faeces > Water hyacinth > Blood from slaughter house > Forest dry litter > Cow dung > Bone meal > Control > Poultry waste.

Leaf Area

Maximum leaf area of 3 months old treated seedlings was measured in soil mixed with goat faeces followed by soil mixed with cow dung. It was however, minimum in soil mixed with poultry waste, with the following descending order-

Goat faeces > Cow dung > Forest dry litter > Blood from slaughter house > Control > Bone meal > Water hyacinth > Poultry waste.

PLATE - 40: POULTRY FARM WASTE: Effect of organic manures on growth performance of ***Vitex negundo*** Linn (Six month treatment).

PLATE - 41: BONE MEAL: Effect of organic manures on growth performance of ***Vitex negundo*** Linn (Six month treatment).



Table - 7.44 Effect of organic manures on number of leaves and leaf area (cm²) of *Vitex negundo* L. seedlings*

Organic manures	Proportion in soil	Seedlings harvested after			
		3 months		6 months	
		Leaves		Leaves	
		Number	Area	Number	Area
Cow dung	20 g/kg	9.20	17.56	30.40	436.76
Goat faeces	20 g/kg	16.00	30.36	46.20	483.49
Poultry farm waste	20 g/kg	7.40	6.05	13.80	119.30
Bone meal	2 g/kg	9.00	8.06	30.20	231.23
Water hyacinth	5 g/kg	10.40	7.16	39.00	262.99
Forest dry litter	5 g/kg	12.00	13.81	34.20	344.69
Blood from slaughter house	3 g/kg	8.60	12.07	38.40	176.22
Control	—	8.40	8.11	22.80	124.24
SEm ±	—	0.62	0.42	1.42	18.20
C. D. 0.05	—	1.28	0.87	2.90	37.31

* Average of 5 plants per treatment

SEm = Standard error of mean

C. D. = Critical difference

The descending order of leaf in 6 months old treated seedlings was as follows:-

Goat faeces > Cow dung > Forest dry litter > Water hyacinth >
 bone meal > Blood from slaughter house > Control > Poultry waste.

Dry Matter Production

Dry matter production of above ground parts in *V.negundo* seedlings as affected by various manures were found to be statistically significant.

Table 7.45, & fig 7.27 indicates maximum dry matter production in stem (0.10 g and 2.04 g) and leaves (0.23 g and 3.69 g) were measured in both three and six months old treated seedlings respectively grown in goat faeces.

The minimum production of dry weight in both stem and leaves were recorded in seedlings grown in poultry farm waste.

The dry matter production of below ground parts was also statistically significant. It also followed the same pattern with maximum and minimum in seedlings grown in goat faeces and poultry waste respectively.

Plant Growth

Result obtained from the experiment showed that the growth

Table - 7.45 Effect of organic manures on dry matter production (g) of *Vitex negundo* L. seedlings*

Organic manures	Proportion in soil	Seedlings harvested after					
		3 months			6 months		
		R	S	L	R	S	L
Cow dung	20 g/kg	0.05	0.04	0.12	2.10	1.81	3.19
Goat faeces	20 g/kg	0.15	0.10	0.23	2.24	2.04	3.69
Poultry farm waste	20 g/kg	0.03	0.02	0.04	0.41	0.41	0.64
Bone meal	2 g/kg	0.04	0.03	0.04	1.32	0.82	1.93
Water hyacinth	5 g/kg	0.06	0.03	0.05	1.26	0.76	2.12
Forest dry litter	5 g/kg	0.10	0.06	0.11	2.24	1.29	2.60
Blood from slaughter house	3 g/kg	0.05	0.04	0.06	0.91	0.69	1.15
Control	—	0.08	0.05	0.06	0.85	0.42	0.93
SEm \pm	—	0.005	0.003	0.005	0.05	0.10	0.13
C. D. _{0.05}	—	0.01	0.01	0.01	0.11	0.21	0.26

* Average of 5 plants per treatment

SEm = Standard error of mean

C. D. = Critical difference

Legends :- R = Root

S = Stem

L = Leaves

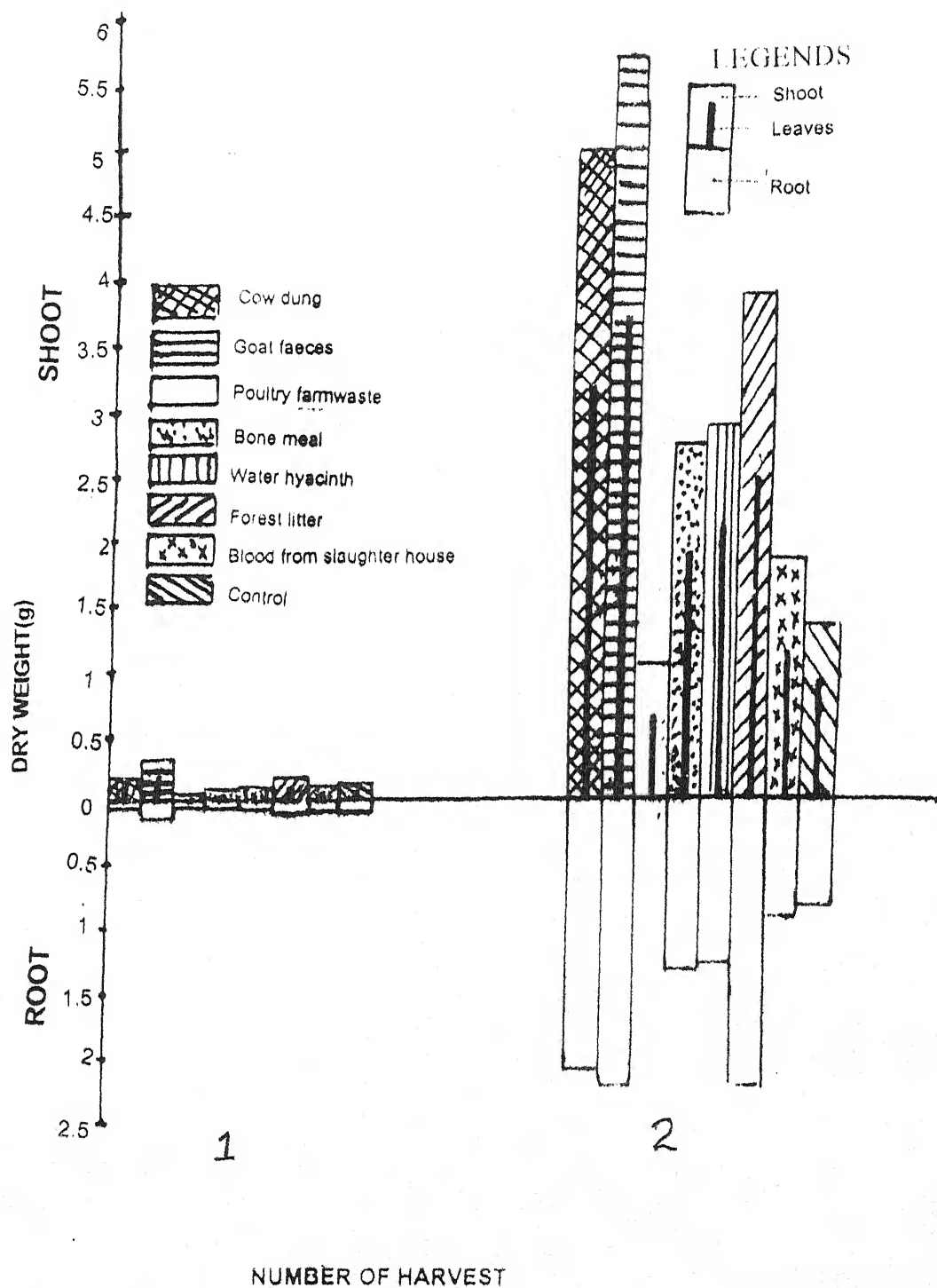
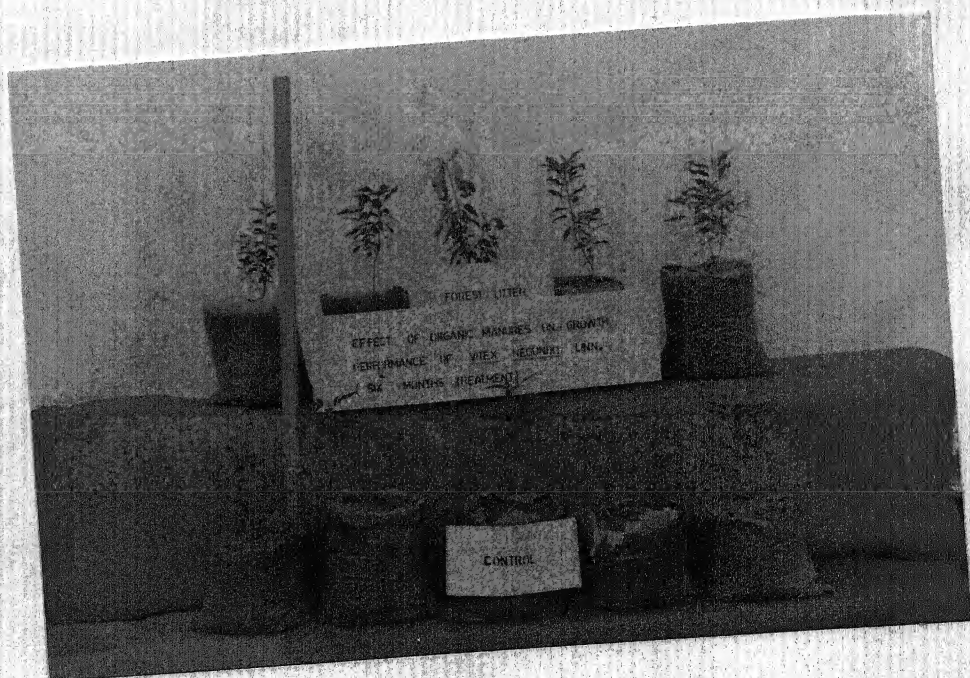


Figure 7.27 Dry weight of *Vitex negundo* seedlings under organic manure treatments.

PLATE - 42: DRY WATER HYACINTH: Effect of organic manures on growth performance of ***Vitex negundo*** Linn (Six month treatment).

PLATE - 43: FOREST LITTER: Effect of organic manures on growth performance of ***Vitex negundo*** Linn (Six month treatment).



behaviour of plant was affected by goat faeces (Table 7.46,7.47,&7.48)

RGR

The growth rate was maximum in goat faeces during first three months followed by forest litter and minimum in poultry farm waste. Between 3-6 months it was maximum in bone meal followed by cow dung and minimum in control. (fig 7.28).

NAR

In harvest I, maximum NAR was computed in the seedlings grown in goat faeces followed by forest litter whereas, minimum was determined in bone meal. In harvest II maximum NAR was recorded the seedlings grown in bone meal followed by forest litter and poultry waste (fig 7.29).

LAR

At the time of first harvesting maximum LAR was recorded in cow dung and in second harvesting it was maximum in poultry waste (fig 7.30).

In both the harvestings LAR was minimum in control.

Table - 7.46 RGR (mg/g/month) of *Vitex negundo* L. seedlings under organic manures treatment.

Organic manures	Proportion in soil	RGR(mg/g/month)	
		3 months	6 months
Cow dung	20 g/kg	240	510
Goat faeces	20 g/kg	360	410
Poultry farm waste	20 g/kg	120	400
Bone meal	2 g/kg	150	520
Water hyacinth	5 g/kg	180	490
Forest dry litter	5 g/kg	280	450
Blood from slaughter house	3 g/kg	190	420
Control	—	220	350

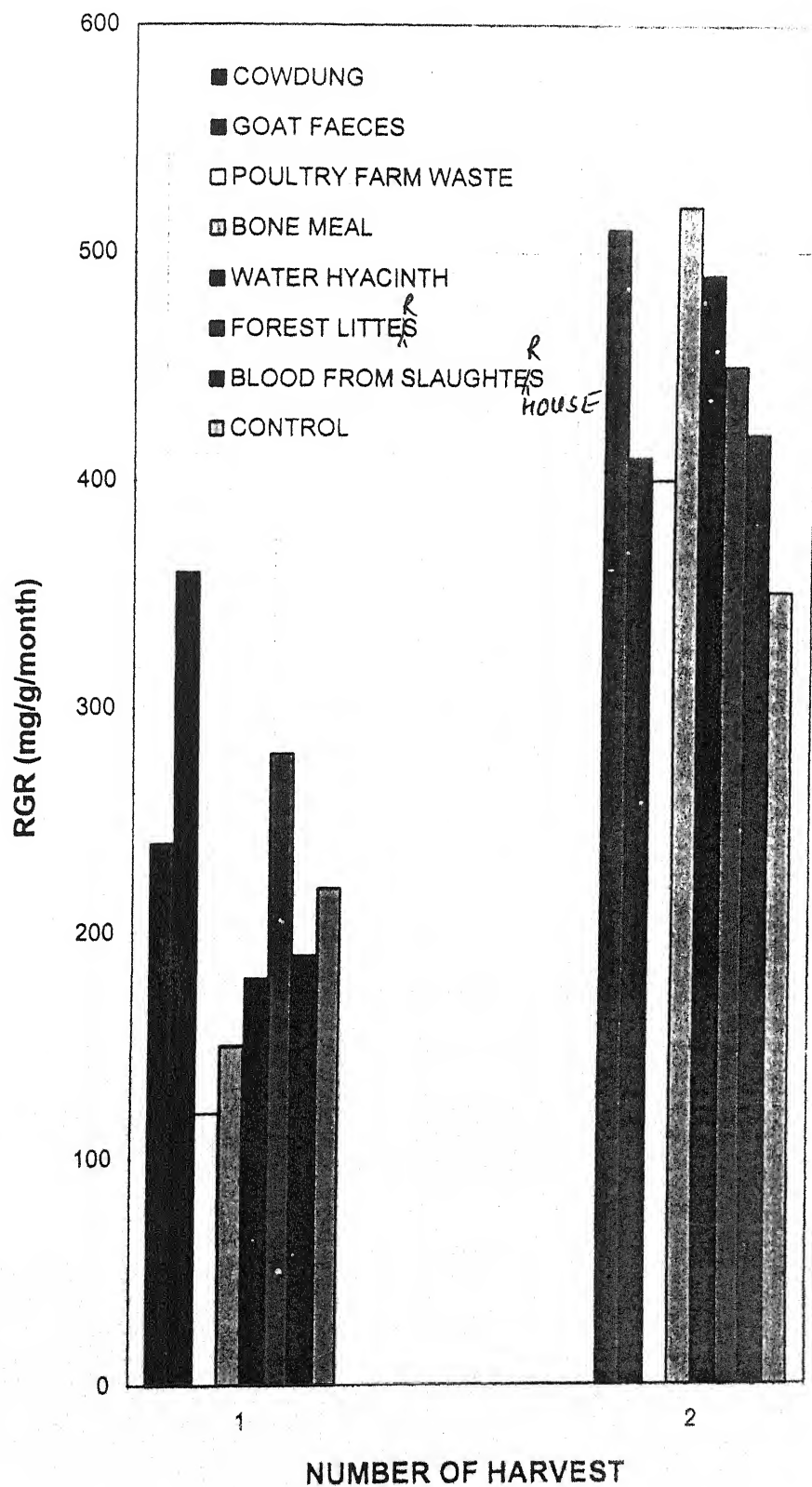


Figure 7.28 RGR of *Vitex negundo* seedlings under organic manure treatments.

Table - 7.47 NAR(mg/cm²/month) of *Vitex negundo* L. seedlings under organic manures treatment.

Organic manures	Prpportion in soil	NAR(mg/cm ² /month)	
		3 months	6 months
Cow dung	20 g/kg	3.3	7.6
Goat faeces	20 g/kg	5.8	6.6
Poultry farm waste	20 g/kg	2.1	5.2
Bone meal	2 g/kg	1.8	8.6
Water hyacinth	5 g/kg	2.9	8.1
Forest dry litter	5 g/kg	5.2	8.2
Blood from slaughter house	3 g/kg	2.8	6.2
Control	—	4.5	6.8

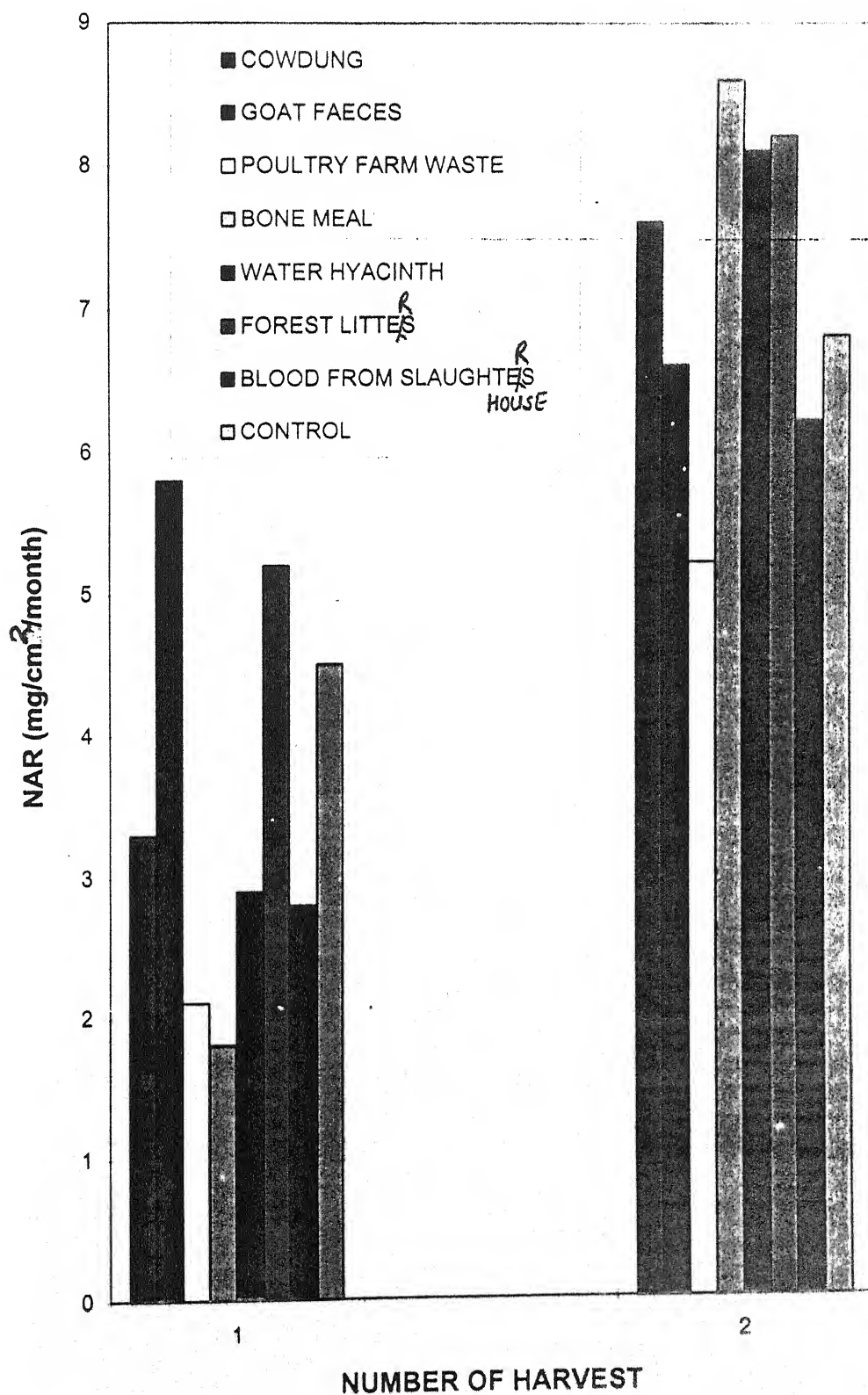


Figure 7.29 NAR of *Vitex negundo* seedlings under organic manure treatments.

PLATE - 44:BLOOD FROM SLAUGHTER HOUSE:
Effect of organic manures on growth performance of
Vitex negundo Linn (Six month treatment).



Table - 7.48 LAR (cm^2/g) of *Vitex negundo* L. seedlings under organic manures treatment.

Organic manures	Prpportion in soil	LAR (cm^2/g)	
		3 months	6 months
Cow dung	20 g/kg	75.97	66.65
Goat faeces	20 g/kg	63.48	61.41
Poultry farm waste	20 g/kg	65.73	77.25
Bone meal	2 g/kg	69.23	60.63
Water hyacinth	5 g/kg	55.97	60.11
Forest dry litter	5 g/kg	55.43	54.80
Blood from slaughter house	3 g/kg	73.67	68.50
Control	—	50.01	51.85

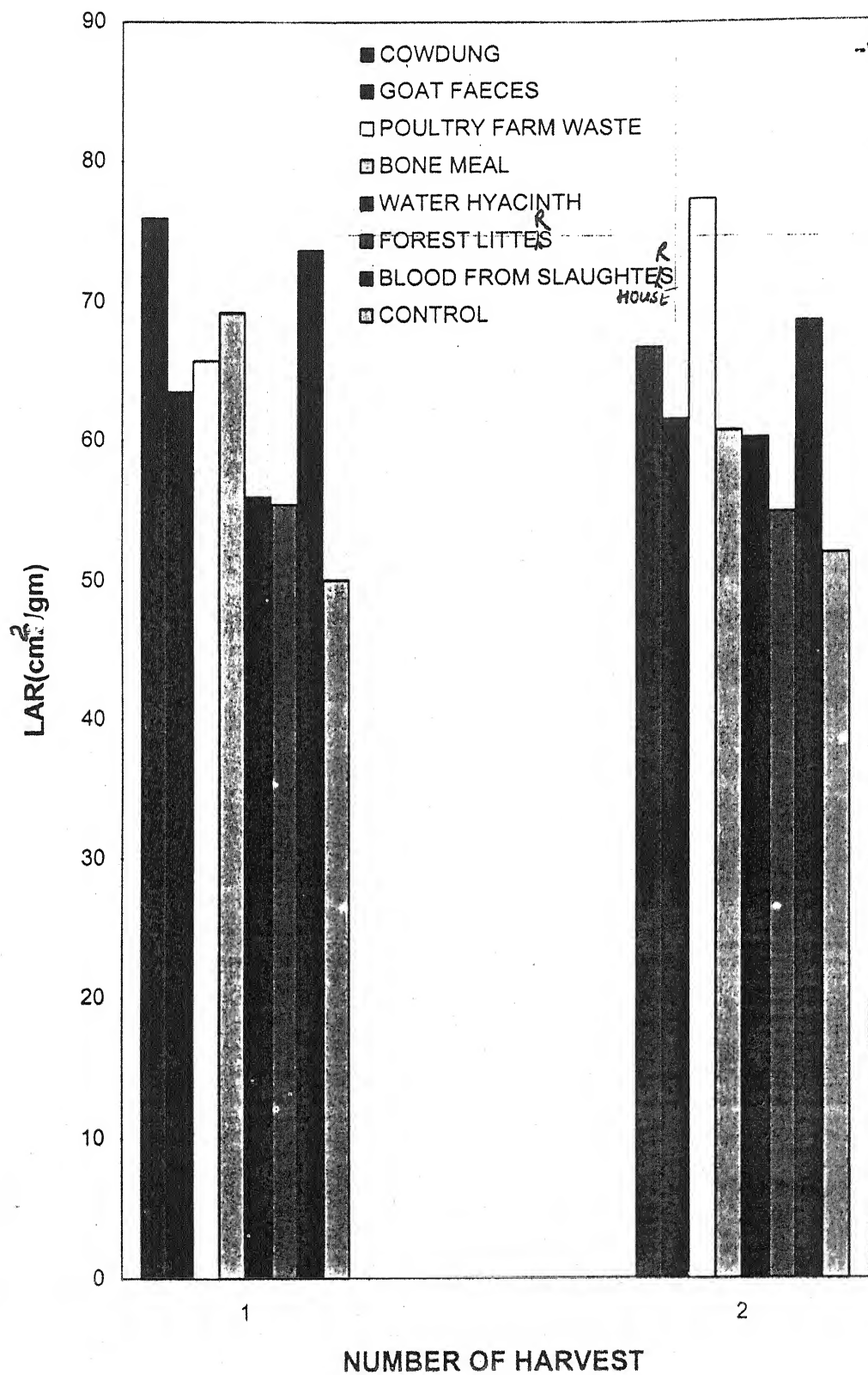


Figure 7.30 LAR of *Vitex negundo* seedlings under organic manure treatments.

In the present study it was observed that both the growth and the biomass production were maximum in the seedlings maintained in soil containing goat faeces, whereas minimum was recorded in the seedlings grown in poultry waste.

Bottomley (1920) opined that the organic matter present in soil work as a growth promoting substance. Further, the humic substances occurring in organic manures due to microbial activities largely behave as auxin (**Hillitzer**, 1932). **Khristeva** (1955) observed that humic substances entering at early stages of development work as supplementary source of respiratory catalyst resulting in increase metabolic activities of plant; intensification of enzyme system; acceleration of cell division; greater development of root system; and alternately the increased dry matter yield.

Kononova (1961) reviewed the effect of organic substance on the growth and development of plants and visualized that the humic substances are converted into highly depressed state favouring their penetration rather easily in the plants.

All these and several other findings support our present study because organic manures, in whatsoever form it may be in long term effects more or less increased the growth as well as, the dry matter production in *V. negundo* seedlings. Obviously in controlled set both the growth performance and the dry matter productions were relatively less as compared with the behaviour of seedlings grown in various organic manures.

The results indicate that in poultry waste seedlings achieved poor growth obviously decreasing the dry matter production. It seems that in poultry waste certain growth inhibiting chemicals might be present which were responsible for the poor performance of the seedlings.

Chapter - VIII

B I B L I O G R A P H Y

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